# PROJECT EXECUTION AND OFFSHORE FIELD DEVELOPMENT IN THE CURRENT OIL MARKET DOWNTURN

A Record of Study

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF ENGINEERING

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December 2016

Major Subject: Engineering

## ABSTRACT

This Record of Study presents the author's experience in the capacity of riser lead and technical advisor working on multiple engineering and management project assignments by Cuneiform Offshore Consulting (Cuneiform). Cuneiform is a consulting firm based in Houston, Texas, specialized in providing engineering, technical advisory and project management services to the offshore energy industry.

The author provided direct technical and managerial support to several of Noble Energy's field developments in Gulf of Mexico (GOM) and Eastern Mediterranean; and, performed CVA (Certified Verification Agent) duties on behalf of BSEE (Bureau of Safety and Environmental Enforcement) by conducting riser design, fabrication and installation verification for risers intended for operation in two different GOM developments.

The author's assignments were comprised of different technical and managerial challenges related to design, engineering, fabrication and installation of offshore risers. A fundamental goal and imperative challenge was to minimize project execution and operational risks and costs.

The author emphasizes the importance of correct hazard identification, appropriate risk assessments, good decision making and judgement to ensure the health, safety and protection of the offshore personnel, the public and the environment, as well as the avoidance of incidents through proper riser design and proper execution to help safeguard the offshore asset and the interest of all stakeholders.

The engineering and execution of offshore dynamic risers require a detailed understanding of the internal and external environment and interfaces. Early assessment of key design considerations during feasibility and concept selection phases was of utmost importance as it allowed for the identification of technical gaps and risk evaluation. Indeed, particular attention was given to the riser type selection philosophy with respect to host floater types, field configurations, environmental conditions, and fluid properties amongst primary parameters.

Moreover, the author's experience highlights the importance of staffing, teamwork, communication, planning, management, leadership and decision making as key factors and challenges to the overall project execution success.

Furthermore, organizational elements such as talent identification, retention and acquisition; continuous investment into innovation and R&D; risk assessment and minimization; ability to adapt to changing market demands; cost control; and maintaining a cash flow positive organization with access to capital are found to contribute to an enhanced operational efficiency.

The thorough assessment of outcomes for each project provided valuable technical and managerial lessons. The acquired experience and proper implementation of the gathered lessons from past projects enables better execution of future projects.

Finally, the overall outcome and success of any project can be judged by assessing its technical rigor and robustness as well as the efficacy in its managerial decisions, approaches, processes, priorities and execution.

# DEDICATION

This Record of Study is dedicated with all my gratitude to my mother and father, my wife Patricia, my son David and my daughter Sasha for their endless patience, support, encouragement and unconditional love.

## ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to the chair of my doctoral committee, Dr. Moo-Hyun Kim for his guidance, advice and encouragement. Since the start of my studies at Texas A&M University, Dr. Kim has always believed in me and expressed great interest in my academic and professional career. I would also like to thank him for the generosity of his time and endless support. Dr. Kim has always inspired me by his dedication, diligence, hard work and passionate attitude.

I would like to acknowledge and thank my committee members, Dr. Hamn-Ching Chen, Dr. Richard H. Lester, Dr. Jun Zhang and my internship supervisor, Dr. Basim Mekha, for their time, great support and invaluable advice throughout the course of this study. I am grateful for their willingness to serve on my doctoral committee and I have been fortunate to have them as my professors, mentors and advisors.

I would like to show my deep gratitude for Dr. Cheung Hun Kim (former Ph.D. committee member), an excellent professor, an acknowledged authority in his field, and a pioneer in numerical wave tank field. He was always interested in my academic and professional progress and achievements, and provided me lots of encouragement and advice. He is an inspiration to me and his memory will be with me always.

I would like to thank Dr. Scott Miller and Mr. Matt Pariyothorn for taking time from their busy schedules to meet with me regarding my desire to enter the Doctor of Engineering program and to discuss with me the steps and all the requirements. I would also like to thank Ms. Sarah Morgan for all her prompt response and helpful assistance especially during the latter part of my Doctor of Engineering program. I would also like to thank Ms. Laura Byrd who has been most helpful, kind and attentive to me and to the CVEN students. She helped me with my Ph.D. candidacy administration as well as my transfer into the Doctor of Engineering (DE) program.

Thanks also go to all my friends and colleagues as well as to the department faculty and staff for making my time at Texas A&M University a great and an enriching experience.

I am also very grateful to all my teachers, professors and mentors throughout my academic years. They have helped me develop the thirst for understanding, and provided me the knowledge and confidence to dream big and work hard toward achieving my goals in life. In particular, I would like to thank Mr. Sharples, my middle school mathematics teacher, and Mrs. Courteaux, my high school physics and chemistry teacher, who helped me excel and love math early and foster a curiosity towards desire to understand science and engineering.

I would like to thank Cuneiform Offshore Consulting and Noble Energy Corporation for the wonderful and truly enriching work opportunities. I had the great pleasure and privilege to meet and work with some remarkable and extraordinary friends and colleagues.

Finally, I would like to thank my family for their endless patience, love, encouragement, and guidance throughout my academic career. All family members, including my wife, son and daughter, mother and father, brother, and my extended family who supported me greatly.

## NOMENCLATURE

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|---|---|
| API | American Petroleum Institute |
| ASME | The American Society of Mechanical Engineers |
| AWS | American Welding Society |
| BSEE | Bureau of Safety and Environmental Enforcement |
| CAPEX | Capital Expenditure |
| CFD | Computational Fluid Dynamic |
| CFR | Code of Federal Regulations |
| COR | Concentric Offset Riser |
| CTR | Cost, Time and Resources |
| Cuneiform | Cuneiform Offshore Consulting |
| CVA | Certified Verification Agency |
| DE | Doctor of Engineering |
| Dipl.-Ing. | Diplôme d'Ingénieur |
| DNV | Det Norske Veritas |
| DSAW | Double Submerged Arc Weld |
| ECA | Engineering Critical Assessment |
| FAT | Factory Acceptance Test |
| FD | Field Development |
| FEED | Front-End Engineering Design |
| FJ | Flexible Joint |

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|---|---|
| FPSO | Floating Production Storage and Offloading |
| FSHR | Free Standing Hybrid Riser |
| FSO | Floating Storage and Offloading |
| GOM | Gulf of Mexico |
| HPHT | High-Pressure High-Temperature |
| HSE | Health, Safety and Environment |
| ID | Inside Diameter |
| IPT | Integrated Project Team |
| ISO | International Organization for Standardization |
| ITP | Inspection and Test Plan |
| KOM | Kick-off Meeting |
| LL | Lessons Learned |
| M&A | Merges & Acquisitions |
| MDR | Master Document Register |
| MMS | Minerals Management Service |
| M.S. | Master of Science |
| NDE | Non-Destructive Examination |
| NE | Noble Energy |
| NPV | Net Present Value |
| OD | Outside Diameter |
| OMAE | Ocean, Offshore and Arctic Engineering |
| OPEC | Organization of the Petroleum Exporting Countries |

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|---|---|
| OPEX | Operational Expenditure |
| OSCR | Offset Steel Catenary Riser |
| OTC | Offshore Technology Conference |
| OTRC | Offshore Technology Research Center |
| P.E. | Professional Engineer |
| Ph.D. | Doctor of Philosophy |
| PM | Project Manager |
| PPM | Pre-production Meeting |
| QA / QC | Quality Assurance / Quality Control |
| R&D | Research and Development |
| ROS | Record of Study |
| ROV | Remotely Operated Vehicle |
| SCR | Steel Catenary Riser |
| SLOR | Single Line Offset Riser |
| SLWR | Steel Lazy Wave Riser |
| TDP | Touchdown Point |
| TDZ | Touchdown Zone |
| TLP | Tension Leg Platform |
| Ti-TSJ | Titanium Tapered Stress Joint |
| TSJ | Tapered Stress Joint |
| TTR | Top Tensioned Riser |
| U.S. DOI | United States Department of the Interior |

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|---|---|
| VIM | Vortex Induced Motion |
| VIV | Vortex Induced Vibration |
| WD | Water Depth |
| WT | Wall Thickness |

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# 1. INTRODUCTION

This Record of Study (ROS) presents the author's internship experience working on engineering and management project assignments from Cuneiform Offshore Consulting (Cuneiform). Cuneiform is a consulting firm based in Houston, Texas, specialized in providing engineering, technical advisory and project management services to the offshore energy industry. This ROS also serves to fulfill the author's degree requirements for the Doctor of Engineering (DE) degree at Texas A&M University.

The title of the ROS is "Project Execution and Offshore Field Development in the Current Oil Market Downturn". The author's title selection stemmed from the fact that this internship has taken place during a severe and persistent oil market downturn cycle which is engrained in the author's internship experience.

Subsequent subsections provide an overview of the internship scope and objectives, a brief introduction about Cuneiform and assigned internship projects, as well as an outline of the sections in the ROS.

## 1.1 Internship Scope and Objectives Overview

The internship is an important requirement for the Doctor of Engineering (DE) degree at Texas A&M University. Indeed one of the objectives of the DE Program at Texas A&M University is to prepare its degree candidates to "work at the highest levels of the engineering profession", through their ability to demonstrate "high technical competence" as well as "professional understanding of the social, political and institutional factors involved" (TAMU, 2006). Graduates of the DE Program are uniquely qualified to fulfill that important role.

The Doctor of Engineering (DE) degree differs from a Doctor of Philosophy (Ph.D.) degree in that it consists of an increased requirement for non-technical/professional development courses, a broader but similar technical curriculum load, a minimum of one year internship under the supervision of a professional engineer (P.E.), and that it is not intended as a research degree (TAMU, 2006).

For the internship, the student and advisory committee develop objectives with the following goals:

> "a. To enable the student to demonstrate an ability to apply knowledge and technical education by making an identifiable engineering contribution in an area of practical concern to the organization or industry in which the internship is served.
>
> b. To enable the student to function in a nonacademic environment in a position where the student becomes familiar with the organizational approach to problems in addition to traditional engineering design or analysis. These may include, but are not limited to, problems of management, environmental protection, labor relations, public relations and economics." (TAMU, 2006).

Throughout my internship, I have focused on the following technical and non-technical objectives approved and defined in my Final Internship Objectives documents (Tavassoli, 2016):

- Have an utmost familiarity with applicable design codes, regulations and standards.
- Ensure that the design effort conducted is safe and robust in order to provide the proper level of health, safety and protection for the offshore personnel, the population and the environment.
- Ensure that decisions taken help prevent incidents to safeguard the offshore asset and the interest of all stakeholders.
- Active participation in hazard identification and appropriate risk assessment/evaluation.
- Dynamically interact with my internship supervisor and expert team members to learn best practices and allow knowledge sharing.
- Be open to new ideas and processes.
- Focus on managerial skills and organizational behavior to enhance teamwork and team dynamic, talent identification and people management.
- Actively observe and familiarize myself with each organization, its personnel, and its management.
- Acquire valuable insight of the organizational vision, mission, values, goals/objectives, competencies, strengths/weaknesses and special processes.

- Gain required knowledge and experience to be able to take the P.E. exam to become a registered Professional Engineer.

Section 5 of the ROS categorized the above internship objectives and provides details to demonstrate that each of the internship objectives has been successfully accomplished and achieved.

## 1.2 Internship Company and Supervisor

My internship was conducted under the supervision of Dr. Basim Mekha who works for Houston based Cuneiform Offshore Consulting (Cuneiform).

Dr. Mekha obtained his Ph.D. from the University of Texas at Austin in 1994 and is a licensed Professional Engineer (P.E.) in the state of Texas with close to 20 years of experience in the Oil and Gas Industry.

Cuneiform is a privately owned firm, specialized in providing engineering, technical advisory and project management services to the offshore energy industry.

Cuneiform is amongst few recognized firms that have been nominated and approved as a Certified Verification Agent (CVA) for design, fabrication and installation verification acting on behalf of the Bureau of Safety and Environmental Enforcement (BSEE). BSEE is an agency under the United States Department of the Interior (U.S. DOI). BSEE was established in 2011 post the Macondo / Deepwater Horizon oil spill disaster to exercise the safety and environmental enforcement functions which were formerly performed under the Minerals Management Service (MMS).

For my internship, the majority of my time was spent at one of Cuneiform's client offices. In addition, I had the opportunity to travel for business meetings with third parties and visit fabrication sites and testing facilities. Section 2 will provide further details and description of my role and responsibilities for the project assignments. Section 4 will present additional specifics about the objective, my experience and outcome of each project assignment.

### 1.3 Record of Study Outline

This ROS documents my experience during the DE internship to demonstrate that the objectives of my internship have been met. The ROS is divided into seven sections.

Section 1 provides an overview of the internship scope and objectives, a brief introduction about the internship company and the assigned projects, as well as an outline of the ROS.

Section 2 presents an overview of my project assignments, followed by a description of my role and position, as well as the nature of my responsibilities and duties for each job assignment.

Section 3 provides a brief introduction to offshore dynamic risers with an overview of primary technical and managerial considerations required during feasibility, final selection and execution of riser design, fabrication and installation.

Details regarding each of my project assignment are provided in Section 4. The scope and objectives of each assignment are explained, a description of my responsibilities and experience are presented, and the outcome of each assignment is discussed.

Section 5 describes and demonstrates the completion of my internship final objectives.

Section 6 provides some general views, personal opinions and lessons learned related to operating companies in a downturn market.

Finally, the conclusions from my internship experience are summarized and included in Section 7.

# 2. PROJECT ASSIGNMENTS AND INVOLVEMENT

This section provides an overview of my two project assignments, followed by a description of my role and position, as well as the nature of my responsibilities and duties for each job assignment.

## 2.1 Project Assignments Overview

As part of my internship I was assigned to the following two Cuneiform project assignments:

- Provide direct technical and managerial support to Noble Energy's Oil & Gas field developments; and,
- Perform CVA (Certified Verification Agent) duties on behalf of BSEE by conducting riser design, fabrication and installation verification for two risers intended for operation in the Gulf of Mexico (GOM). Each riser is associated with a different oil & gas development in the GOM.

The assignments dealt with different technical and managerial challenges related to design, engineering, fabrication and installation of offshore risers. Proper resolution of these type challenges plays an important role in the overall success of an offshore oil & gas development.

The following subsections will provide an overview of each assignment.

### 2.1.1 Noble Energy Assignment

This assignment required direct technical and managerial support to Noble Energy's Oil & Gas field developments.

Noble Energy (NE) was founded by Lloyd Noble in 1932 and is one of the first independent energy companies to explore offshore in the Gulf of Mexico. NE has also been active onshore US and offshore West Africa and offshore Eastern Mediterranean (Noble Energy, 2016a, 2016c).

NE prides themselves with the following strong value statement:

"Founded in 1932, Noble Energy has succeeded where others would not venture – applying global experience to safely and responsibly create new opportunities. The company has proven its ability to move from discovery to efficient execution of large-scale development projects and has additional major projects under development.

Noble Energy (NYSE:NBL) is an independent oil and natural gas exploration and production company with a diversified high-quality portfolio of both U.S. unconventional and global offshore conventional assets spanning three continents. The company is committed to safely and responsibly delivering our purpose – Energizing the World, Bettering People's Lives." (Noble Energy, 2016a).

I supported NE corporation on several of their major domestic and international field developments. During the course of my internship, I had the great opportunity to be involved in several of these developments at a given project phase and had the ability to follow some of them through different phases. This allowed me to participate in and contribute to various interesting project stages including:

- Project Feasibility Evaluation
- Concept Selection
- Qualification
- Front-End Engineering Design (FEED)
- Specification Development
- Tendering and Bid Evaluation
- Project Execution

I therefore had the unique opportunity to familiarize myself with NE's project execution and management processes, style, structure and organization which were dictated and influenced by their distinct and notable mission statement as follows:

"At Noble Energy, we are driven by our purpose - Energizing the World, Bettering People's Lives®. We believe in safely and responsibly providing energy to the world through oil and natural gas exploration and production, while positively influencing the lives of our stakeholders. We strive to be the energy partner of choice, a responsible corporate citizen and the preferred employer of the industry's top talent." (Noble Energy, 2016b).

In particular, each of NE's field developments have a dedicated project team organized under an integrated project team (IPT) umbrella. Hence, my experience was further enriched through the extensive collaboration and interaction with the different members and the project manager of each IPT. In addition to those internal interactions, I was also exposed to numerous and frequent external interactions with the various NE contractors.

### 2.1.2 CVA Assignment

The second assignment was focused on the design, fabrication and installation verification (CVA scope) on behalf of BSEE. Cuneiform was designated as the CVA (Certified Verification Agent) for two risers intended for operation in two different GOM oil & gas developments. It should be noted that one of the two developments (CVA #1) has been suspended while the second is currently underway.

Unfortunately, due to the oil market downturn conditions, the initially selected installation contractor on the now suspended development (i.e. CVA #1) went out of business and all its Houston personnel were let go. Hence, the installation verification assignment has been placed on hold while the operator is seeking to rebid the installation scope of work in order to select a new installation contractor.

Cuneiform is currently working on the second CVA scope (CVA #2). The verification scope is ongoing and expected to be completed by the end of this year.

## 2.2 My Positions and Responsibilities

I would like to begin by briefly stating some of my industry experience prior to the commencement of the internship. I trust this explanation will help elucidate the basis for my more advanced technical and managerial positions and higher responsibilities during my internship as compared to positions and responsibilities I would have had if I had less industry experience.

Prior to the start of my doctoral internship I had spent over 15 years in the marine research and offshore industry, primarily in the field of floating systems, deepwater risers and pipeline systems. I had held various positions and responsibilities including Lead Engineer, Project Coordinator, Project Manager and Technical Advisor providing consultancy services for riser, pipeline, umbilical, floating and mooring system projects as both client and contractor.

In addition to my industry experience, during my Master of Science (M.S.) degree and part of my doctoral degree at Texas A&M University, I had worked on two separate computational fluid dynamic (CFD) codes that were based on solving the Navier-Stokes equations. I had developed a numerical code capable of simulating nonlinear wave-current-structure interactions that account for the effect of fluid viscosity. I had also helped in re-coding an existing numerical wave tank to improve its 3-dimensional wave generation capabilities. The capabilities of the numerical wave tank were then successfully compared to those generated by the Offshore Technology Research Center's (OTRC) physical wave test tank. The OTRC facility is located in College Station, Texas and is jointly operated by Texas A&M University and the University of Texas at Austin (OTRC, 2016).

The following sections will provide a description of my role, position and responsibilities for each job assignment. The technical nature, administrative duties and managerial responsibilities of my job assignments will be highlighted and further explained.

### 2.2.1 Noble Energy

The assignment to Noble Energy (NE) required technical support on several major and strategic field developments. As such, I had the great opportunity to work with multiple integrated project teams (IPTs) and project managers (PMs) as well as numerous contractors and bidders.

As explained in Section 1, during the time of my internship these field developments were at different project stages which varied my assignment roles in terms of managerial responsibilities and technical areas of expertise. Indeed, managing the delivery of a component to be installed offshore under extreme schedule constraints is quite different from supporting an operator with field development concept selection and performing or managing a contractor's verification of solution feasibility.

In order to preserve some of the proprietary nature of my assignment, each field development (FD) or prospect will be given a number (i.e. FD #1) rather than its field development name.

As part of my assignment for NE, I was responsible for the following field developments activities:

- FD #1:
  - Description: Riser top termination qualification
  - Project stage: Component qualification, testing and partial delivery of reusable parts
  - Position: Riser Lead and Technical Advisor
  - Technical duties: I worked on the project as the riser lead and technical advisor by providing technical support during design, fabrication and testing of both a production and a gas export riser top termination units.
  - Managerial duties: Responsible for managing and coordinating portion of the manufacturing activities and all of the prototype qualification testing program. Managed the day-to-day qualification test activities of two riser top termination units that are intended for an overseas field development.
  - Brief outcome: Both riser top termination units were successfully tested and qualified for use within a defined range of challenging design conditions and parameters.

- FD #2:
  - Description: Delivery (including design, fabrication and installation) of two production riser systems and two spare riser top termination units for GOM field
  - Project stage: Project execution
  - Position: Riser Lead and Technical Advisor
  - Technical duties: For this project, I was the riser lead and technical advisor providing responses to various riser related queries, and interfacing with multiple teams and parties such as the riser contractors, third party verification engineering company, topsides facilities, floating hull and mooring, controls, systems, subsea infrastructure, reservoir, flow assurance, materials, welding, quality, health and safety, regulatory and operations teams. I had extensive involvement in review and consolidation of comments to riser related activities. I provided technical assistance for the riser/hull interfaces and for riser offshore installation activities.
  - Managerial duties: I was responsible for managing the delivery of two production riser systems including two riser top termination units for one of NE's major GOM fields. I was also responsible for managing and coordinating the design, manufacturing, weld qualification program, testing and delivery of the riser top termination units in compliance with design requirements, approved specifications,

procedures and ITP's. Additionally, I supported the delivery of two spare riser top termination units, and led the coordination of riser and gas lift umbilical Certified Verification Agent (CVA) scopes.

  - Brief outcome: The two production risers have been successfully installed and are now operational, producing oil back to a tie-back floating platform host in GOM. The spare production riser top termination units and the spare long-lead forgings were delivered and placed in NE's storage facility.

- FD #3:
  - Description: High-pressure high-temperature (HPHT) GOM field tie-back
  - Project stage: Concept development, project feasibility evaluation, schedule and cost assessments
  - Position: Riser Lead and Technical Advisor
  - Technical duties: I worked on the project as the riser lead and technical advisor involved in the concept development and evaluation of a high-pressure high-temperature (HPHT) 15ksi production riser tie-back solutions to several potential host options in GOM. Both steel and flexible riser options were assessed for each host in terms of design, fabrication and installation feasibility as well as for reliability, risk, cost and schedule.

- Managerial duties: I managed the feasibility study and cost estimate scope for the flexible riser and flowline solutions. I coordinated the conceptual and preliminary engineering work scope carried out by flexible pipe supplier.
- Brief outcome: The riser feasibility phase was completed. A base and alternative solutions were defined. The next phase of the project is anticipated to start after a successful drilling program and based on the state of the oil market.

- FD #4:
  - Description: Riser design feasibility and selection in eastern Mediterranean Sea's deepwater
  - Project stage: Feasibility evaluation, concept selection, risk assessment, schedule and cost estimation, specification development, FEED, tendering and bid evaluation
  - Position: Riser Lead and Technical Advisor
  - Technical duties: I worked on the project as the riser lead and technical advisor, responsible for leading the riser design feasibility and selection in the eastern Mediterranean Sea's deepwater development sites. I worked closely with engineering contractor's riser team to ensure that all aspect of riser design such as strength, wave/VIV/VIM fatigue, interference and installability were verified. I was the client's riser lead

and technical advisor for hull and riser selection studies. Responsible for producing the Basis of Design document and defining Scope of Works and Owner Specification documents for the riser detailed design execution scope as well as for several of the study scopes. Furthermore, I assisted the subsea team in evaluating flexible versus steel riser, flowline and jumper solutions.

  - Managerial Duties: Coordinated and managed the riser design feasibility scope and selection studies. I helped coordinate the riser related interfaces with affected project teams and third parties. I coordinated the riser contractors' on time and on budget verification scope and final documentation delivery. In addition, I prepared and issued quote inquiries and facilitated the feasibility and cost evaluation of flexible pipe solutions for riser, flowline and jumper alternatives.
  - Brief outcome: The riser feasibility and selection phase have been completed. Further assessment leading to next phase of the project is pending successful partner agreements, regional negotiations and regulatory approvals.

- FD #5:
  - Description: In-house development of Company standards and specifications with inclusion of lessons learned from past projects. Primary goal was to enhance operational efficiency, help with process

uniformity across NE's major projects, minimization of project execution cost and schedule delays by avoidance of change orders.

- Project stage: Specification Development
- Position: Riser Lead and Technical Advisor
- Technical duties: I was tasked with preparing and reviewing several riser related specifications, as part of NE's ongoing strategy for enhancing its project execution and operational efficiency, safety and quality. This strategic effort relied heavily on NE's past project execution experience and lessons learned, while ensuring compliance with current codes, regulations, industry standards, recommended practices and norms; as well as, on positive interaction and valuable review feedback from other company experts.
- Managerial duties: My task was primarily technical and administrative with quick review and comment turnaround time reporting to assigned document owner.
- Brief outcome: The primary specifications have been developed and reviewed by members of task team. Comments were consolidated by document owner and then discussed with NE's technical authorities and project director.

In addition to technical and managerial responsibilities, I had to coordinate the following administrative duties as part of my overall assignment:

- Provide daily or weekly update reports to management
- Arrange internal meetings
- Arrange meetings and teleconferences with NE contractors
- Review contractor documentation and submit comments through NE's document control system
- Review and approve contractor milestone invoices and inspector invoices
- Coordinate inspectors for witness and hold points per approved ITP (Inspection and Test Plan)
- Prepare and submit timesheets

### 2.2.2 CVA

My other assignment was focused on the design, fabrication and installation verification (CVA scope) on behalf of BSEE for two different risers associated with two different Oil & Gas developments in the Gulf of Mexico.

I have been part of a team responsible for conducting the independent design, fabrication and installation verification.

For the first CVA scope (CVA #1), I performed and led part of the design verification activities and participated in the preparations and review of the Interim and Final Design CVA reports. My other main responsibility was comprised of reviewing installation analysis documents as well as coordinating and managing all offshore installation related verification activities and reporting to BSEE.

As explained earlier, the installation verification assignment has been placed on hold until the operator rebids the installation scope of work and selects new installation contractor.

For the second CVA scope (CVA #2), my responsibility has consisted of leading the design verification activities for a riser modification and reporting to BSEE. I will also participated in the fabrication and installation reviews and verifications. As I write this ROS, this work scope is still underway and I will continue to be involved until completion of the verification scope.

## 2.3 Extra Involvement Opportunities

In addition to the project assignment described in the previous sections, I once again had the wonderful opportunity to be invited to present at one of the Ocean Engineering seminar sessions; this time, on the topic of the "First FPSO project development in the US Gulf of Mexico". In my presentation, I described the project challenges and my project experiences, discussed the long existing history of FPSO's operating fields around the world, and explained some of the reasons for the late arrival of FPSO to operate in the US GOM. It is always a great privilege to be able to share my experience and knowledge with my fellow Aggies and to learn through our mutual discussions.

Again this year, I also enjoyed the chance to accept the invitation from OMAE to peer review technical papers for the International Conference on Ocean, Offshore and Arctic Engineering. This year, I completed the peer review of two technical papers for the ASME 2016 – 35th International Conference on Ocean, Offshore and Arctic Engineering that was held in Busan, South Korea. Unfortunately, due to confidentiality of the organizer, session chair(s), author(s) and paper I am unable to discuss details pertaining to reviewed papers and their outcomes.

# 3. BRIEF OVERVIEW OF OFFSHORE DYNAMIC RISERS

This section provides a brief introduction to offshore dynamic risers with an overview of the primary technical and managerial considerations required during feasibility, final selection and execution of riser design, fabrication and installation. Furthermore, the riser type selection philosophy with respect to floater types, field configurations, and environmental conditions are outlined. An important and key objective in the selection of a riser concept based on qualified and proven solutions, is to minimize project execution and operational risks.

Indeed, the design and engineering of these dynamic structures require a high level of expertise and detailed understanding of the internal and external environment and interfaces. This understanding and expertise are imperative to ensure a safe and robust design that provides the proper level of health, safety and protection for the offshore personnel, the population and the environment. The avoidance of incidents through proper riser design also helps safeguard the offshore asset and the interest of all stakeholders. Correct hazard identification and appropriate risk evaluation is of paramount importance.

## 3.1 What are Risers

Risers are pipes hanging through the water column that connect the production facility located above the surface of the water to the pipelines and structures on the seafloor (also referred to as the subsea infrastructure). Hence, they are conduits that transfer materials between the seabed and the surface host. The host may either be a production or a drilling facility.

Risers primarily serve for the transportation (import or export) of untreated or treated well fluids, and for drilling activities (i.e. mud transfer). Additionally, fluid injection risers may be utilized to inject water or gas into the oil formation to enhance reservoir production recovery. They are also used for gas lift or chemical injection to help the well fluid flow to the surface facility.

## 3.2 Riser System Classification

This section provides a brief synopsis of the typical riser system classification used for solution screening and selection during the initial phase of concept feasibility.

Deepwater production riser systems can be classified under two major categories:

- Free hanging risers
- Top tensioned risers

As summarized in Figure 3.1, a further break-down places the following types of field proven risers under "Free hanging risers":

- Steel Catenary Risers (SCR):
    - Simple Steel Catenary Risers
    - Wave Shape Risers

- Unbonded Flexible Risers:
    - Metallic Unbounded Flexible Risers
    - Non-Metallic Unbounded Flexible Risers
    - Metallic & Non-Metallic Hybrid Unbounded Flexible Risers
- Offset Free-Hanging Risers

Under the “Top tensioned” riser (TTR) category the following riser solutions are found:

- Top-tension risers on floating production platforms (Buoyancy Air Tank Tensioner, Hydro-Pneumatic Tensioner)
- Free Standing Hybrid Risers (FSHR, SLOR, COR, bundled riser tower)
- Bonded non-metallic (Composite) risers

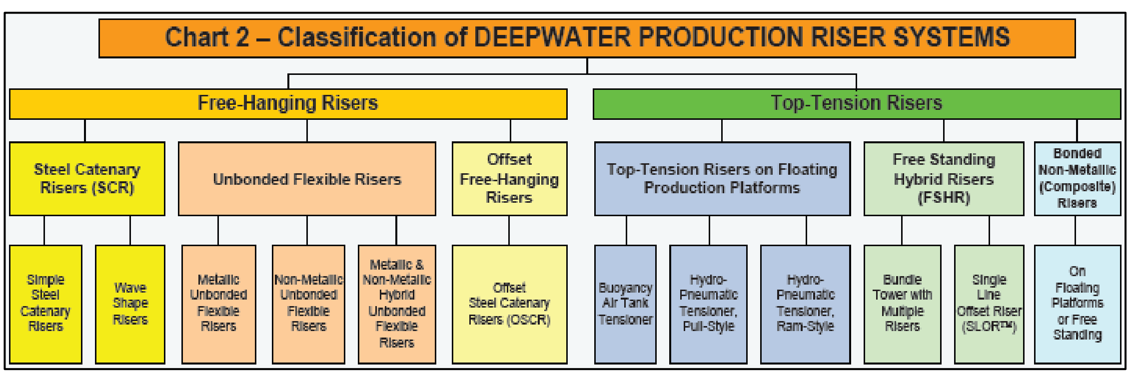


Figure 3.1. Classification of deepwater production riser systems. (Shu et al., 2010)

## 3.3 Rigid and Flexible Riser Pipe

As noted in the previous classification section, a riser pipe may be defined as "rigid" or "flexible" based on the structure of its cross-section.

Rigid riser pipes are typically made from high grade steel pipes, whereas flexible pipes have a more complex cross-sectional structure composed of several metallic and non-metallic layers, each fulfilling a particular function.

A typical unbounded flexible pipe structure is shown in Figure 3.2. The main layer of the flexible cross-section are described below: (API RP 17B, 2014)

i) Carcass: Interlocked metallic layer which provides collapse resistance due to hydrostatic pressure and crushing resistance during installation and service life. This layer is not leak proof and for "rough" bored flexibles is in direct contact of bore fluids.

ii) Pressure sheath: Extruded polymeric material which contains internal fluid integrity and transfers loads due to internal fluid pressure to the pressure vault.

iii) Pressure vault: Interlocked metallic layer which supports the pressure sheath and provides resistance against pressure loads in the radial direction. Additional pressure armor layer may be added for high pressure application.

iv) Tensile armours: These layers typically consist of flat, round, or shaped metallic wires, in two or four layers cross-wound at an angle between 20 degrees and 60 degrees. These layers provide resistance to longitudinal forces from tension or compression and end-cap effects. They also provide strength against hoop and radial stresses from internal pressure. For some applications where pressure armour layer is not utilized, these armour layers are cross-wound at approximately 55 degrees to achieve a torsionally balanced pipe and to balance hoop and axial stresses.

v) Anti-wear tapes: These tapes prevent/limit wear between the metallic layers of the riser.

vi) High strength tapes: These tapes help prevent disorganization of armours.

vii) Outer sheath: This is an extruded polymeric material which protects the pipe inner layers from seawater ingress and other external conditions.

The material selection, thickness and sequence of each metallic and non-metallic layer; as well as, the type, lay angle and number of the steel wires in the pipe cross-section are determined and governed by fabrication limitations, in-service requirements and installation conditions. Also, the material selected for each layer of the cross-section as well as the flexible pipe as a system shall be fully qualified for the given project application.

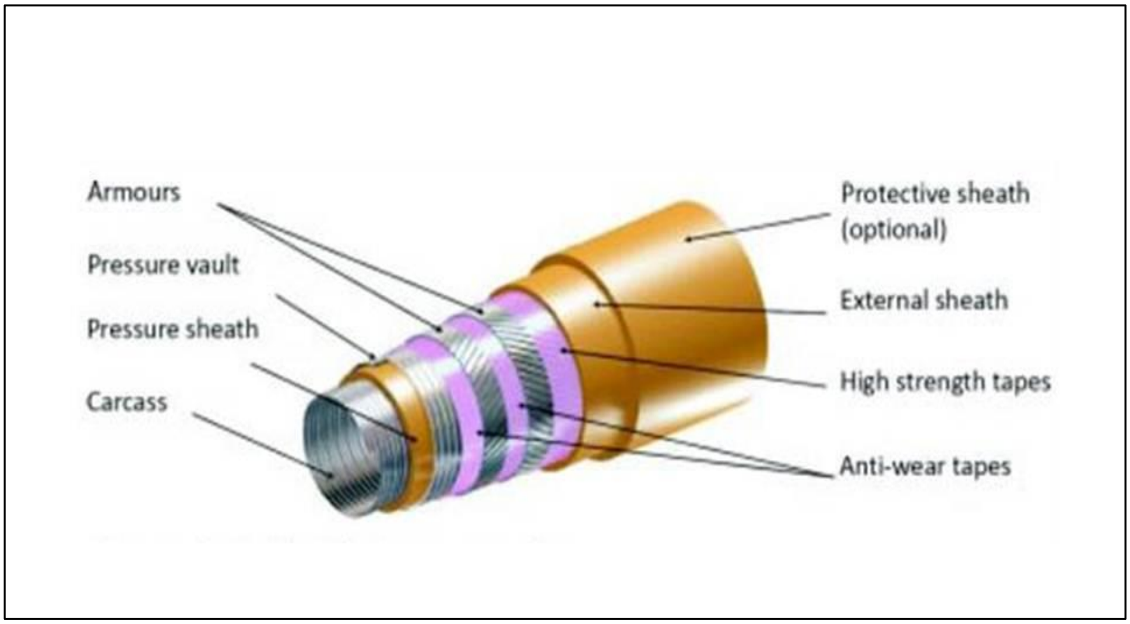


Figure 3.2. Typical flexible riser pipe structure. (Ismail, 2014)

### 3.4 Key Factors for the Riser Design and Final Selection

For the riser design and final selection the primary factors that need to be considered are listed below:

- Water depth
- Floating host motion performance
- Environmental loading (wave motion, current, VIV, VIM etc…)
- Flow assurance (riser pipe ID, thermal coating requirement, etc…)
- Pressure (including pressure fluctuations)

- Temperature
- Riser fluid composition
- Sour service
- $CO_2$ presence
- Field layout
- Material selection and chemical compatibility
- Corrosion
- Manufacturability and procurement
- Riser connection to host
- Installability
- Operations
- Risk and reliability
- Riser integrity and maintenance

Indeed, minimizing company and project risk is one of the key and fundamental decision-making drivers. This effort leads to selecting a qualified and field proven riser solution whenever possible.

It should be noted that many of the major operators have been extremely risk averse and would therefore strive to stay away from non-field proven solutions. Only a few operators are actually keen on setting and claiming firsts by qualifying new solutions and opt for novel and non-field proven solutions.

It is therefore essential to ensure that during design and prior to final selection any technological gap have been clearly identified in terms of design and engineering, manufacturability, installability or operability.

The qualification cost and schedule for each identified technological gap shall then be determined and the risk of an unfavorable outcome shall be assessed. The decision as to proceed with qualification effort can then be made with complete and proper knowledge.

Lastly, for the final selection based on technically proven and feasible riser solutions the following key aspects need to be factored into the decision:

- Safety, quality, risk & reliability
- Overall cost (CAPEX and OPEX)
- Delivery schedule

## 3.5 Riser/Hull Selection Philosophy

Amongst the key riser design factors listed in Section 3.4, one of the major factors governing the riser design is the vessel motion performance. The vessel motion affects the riser strength and fatigue performance at the vessel hang-off location and at its touch-down zone (TDZ) (for “free-hanging” riser type) or at its riser base region (for the “top-tension” riser type).

Riser’s motions and loading, at its hang-off and seabed, result from the combination of the floating host’s response to environmental conditions (such as waves, winds and currents) as well as from the environmental conditions directly acting on the riser (such as currents causing VIV).

Some of the typical host solutions selected for offshore field development are listed below:

- Jacket/Fixed Platform
- Compliant tower
- TLP (mini-TLP, classical, new generation)
- Spar (classical, truss, cell)
- Semi (different types)
- FPSO and FSO (spread moored; external or internal turret moored)
- MonoBR

The selection decision is based on the following essential parameters and considerations:

- Environment
- Water depth
- Processing and operational requirement
- Regulatory
- Geographical
- Riser feasibility and technical drivers
- CAPEX and OPEX
- Risk analysis

FPSO's or FSO's are often the preferred option due to certain technical, operational, geographical and economic reasons. However, the motions of these ship-shaped systems are typically more severe than the motions of other types of floating facilities such as TLPs, Spars or Semi-submersibles. This is due to their heave, roll and pitch motion response being in the same frequency range as the wave energy. Thus riser system feasibility is of much greater challenge on an FPSO than on a TLP, Spar or Semi-submersible host facilities.

Indeed, the more dynamic floating hosts such as FPSO's have been typically used in less severe metocean conditions, such as those in West Africa. Whereas, in the Gulf of Mexico (GOM) or the North Sea, less dynamic vessels such as TLPs, Spars, and semi-submersibles are typically used to accommodate the harsher metocean conditions.

The first FPSO in the US GOM, is the one for Petrobras America's Cascade & Chinook development, with a disconnectable turret which allows the FPSO to disconnect from the risers and sail away from hurricanes and major storms.

In offshore Eastern Mediterranean for instance, the environmental conditions are not as benign as that of West Africa, however when they are compared to the GOM criteria, there are no hurricanes, and the ocean currents are found to be less onerous, however the fatigue sea-states are quite similar to those of GOM.

For FPSO as host facility the following solutions are proven, albeit not in very harsh environmental conditions:

- Simple steel Catenary risers
- Wave shape steel risers (such as lazy wave, steep wave, lazy S, steep S, etc…)

- Unbounded flexible risers (metallic and non-metallic)
- Hybrid riser towers (single or bundled)

It is to note, that few projects have adopted the use of a dry tree unit (TLP or Spar) in combination with an FPSO to mitigate some of the riser challenges, whereby the risers are attached to the dry tree unit with better motions than the FPSO. The produced fluids are then transferred via transfer lines to the FPSO for further processing and offloading. However, this option requires heavier CAPEX and has its pros and cons.

Flexible risers are generally not as sensitive to vessel hang-off motions and have better dynamic performance than steel risers; however, flexible risers are typically more costly and are limited by water depth, pressure rating and bore size. Hence, many of the major operators prefer the use of free hanging steel risers, in particular, for their larger bore export risers in deepwater projects. Few operators that have extensively used flexible in the past have now adopted the steel risers as a cost-effective alternative for their oil and gas export risers.

Hybrid riser towers (single or bundled) consist of vertical steel pipe(s) tensioned by near surface buoyancy tank and flexible jumper(s) connected between the top of the riser and the floating host. Hybrid riser towers provide a feasible solution for a variety of water depths, floating hosts, environmental conditions and riser bore sizes. This is in part achieved by decoupling the floating host motions from the riser via the flexible jumper(s). However, the benefits of this improved riser response and performance comes with significant amount of CAPEX as well as complex and high project execution and schedule risks as well as cost associated with a more involved and onerous integrity management OPEX costs. Below is a list of some of the advantages and disadvantages for the hybrid riser towers:

- Some of the advantages of hybrid riser tower:
  - Particularly suitable in ultradeep water and high pressure fields
  - Allows effective decoupling of riser / host vessel motion
  - Riser pay-load reduction
  - Use with any host in harsh environment
  - Suitable with FPSO host and riser disconnect requirement
  - Decoupling riser installation from production host arrival
  - Reduced field footprint
- Some of the disadvantages
  - More complex
  - Schedule risk
  - Procurement risk
  - Complex delivery management of long-lead item
  - Large installation spread
  - Higher CAPEX and OPEX costs
  - More onerous integrity management

Therefore, the use of free-hanging steel risers (SCRs) is often the preferred solution by most operators as it is considered to be the simplest and least expensive riser concept for subsea developments.

The major areas of concern for dynamic response of SCRs are the hang off region and touch-down zone (TDZ). One effective way of reducing/isolating the TDZ dynamic response from floating host motion is by means of a "wave shaped" riser. The lazy wave configuration is one shape that achieves this goal by using buoyancy modules along a region of the riser creating a subsea "arch" or "wave" within the SCR. Steel Lazy Wave Riser (SLWR) has attracted more attention in recent years due to its good motion isolation effect between TDZ and hang off, thus mitigating the strength issues as well as improving the fatigue life significantly near the TDZ. The first implementation of the steel lazy wave risers is with a turret moored FPSO for Shell's Parque Das Conchas (BC-10) development, offshore Brazil in Compos Basin.

## 3.6 Overview of Riser Design Process

The typical process followed for riser design may be summarized as follows:

- Define Basis of Design - Input and interface data
- Mechanical Design - Material and WT selection
- Define riser layout and global configuration
- Strength and fatigue analysis considering:
    - Wave

    - VIV (Vortex Induced Vibration)
    - VIM (Vortex Induced Motion)
    - Any other applicable loading such as seismic, ice, pressure fluctuations, etc…
    - Fabrication / Transportation
    - Installation
    - In-service intervention
- Component design
- Interference / Clearance check
- Interface loads (Extreme and Fatigue)
- ECA (Engineering Critical Assessment)
- Manufacturing / Welding and NDE
- Installability
- Integrity and monitoring requirement
- Commissioning

Each of the riser design steps, emphasized in the general process above, shall comply with applicable design codes, regulations, standards, specifications and best practices. Several of the primary ones are listed in Figure 3.3.

- API RP 2RD “Recommended Practice for the Design of Risers for Floating Production Systems (FPSs) and Tension Leg Platforms (TLPs)”
- API RP 17B “Recommended Practice for Flexible Pipe”
- API Spec 17J “Specification for Unbonded Flexible Pipe”
- API RP 2A-WSD “Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms”;
- API RP 1111 “Design, Construction, Operation, and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design)”;
- API Specification 5L “Specification for Line Pipe”;
- API STD 1104 “Standard for Welding of Pipelines and Related Facilities “
- API 17TR2 “The Aging of PA-11 in Flexible Risers”;
- ASME B31.4 “Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids”;
- ASME B31.8 “Gas Transmission & Distribution Piping Systems”;
- ASME B16.5 “Standard for Pipe Flanges and Flanged Fittings”
- ASME Section VIII “Boiler and Pressure Vessel Code (BPVC), Section VIII”
- DNV OS F201 “Dynamic Risers”;
- DNV RP C203 “Fatigue Design of Offshore Steel Structures”;
- DNV RP F103 “Cathodic Protection of Submarine Pipelines by Galvanic Anodes”;
- DNV RP B401 “Cathodic Protection Design”;
- DNV RP F108 “Fracture Control for Pipeline Installation Methods Introducing Cyclic Plastic Strain”;
- BS 7910 “Guide to Methods for Assessing the Acceptability of Flaws in Metallic Structures”;
- AWS D1.1 “Structural Welding Code”
- Federal Regulations 49 CFR Part 192 “Transportation of Natural and Other Gas by Pipeline; Minimum Federal Safety Standards”;
- Federal Regulations 30 CFR Part 250 “Pipelines and Pipeline Right-of-Ways”

Figure 3.3. Main design codes, regulations, standards, specifications and recommended practices applicable to risers.

## 3.7 Riser Design – Current State of the Art

Riser designers ought to be aware of the important technical issues and gaps that set the boundaries of proven technology, as well as component designs that have limited number of available qualified suppliers. Lack of knowledge or awareness will most certainly have a drastic effect on the project cost, schedule and risk exposure.

Some of the critical technical issues undergoing research or qualification are listed below:

- Steel and flexible (unbounded and bounded) riser pipe manufacturing limits
- Sour service requirements and limitations
- Corrosion fatigue issues and clad design and qualification
- Material and chemical compatibility risks
- High grade steel and weldability and product quality limitations
- HPHT impact on riser design, pipe requirement and payload
- Flexible pipe qualification for deeper depth and higher internal pressure
- Advancement in unbounded and bounded flexible pipe
- Use of composite materials
- Use of thick-walled equipment and failure mode identification and assessment
- Buckle and collapse resistance design considerations
- Riser compression near TDP
- Flexible Joint fatigue performance and reliability when subjected to high pressure fluctuation, high pressure or high temperature
- Ti-TSJ: Weld qualification and flaw detection issues with titanium forged pipe
- Chemical compatibility and corrosion risks to be addressed with use of Ti-TSJ
- Forging material requirement and delivery challenges
- Advancement of thread connector for SCRs
- Riser coating issues with increased temperature and water depth
- Field Joint coating selection

- Accurate modelling of riser and soil interaction rather than typical linear spring model based on hard seabed assumption
- VIV commercial software limitations and questionable results
- Advancement in VIV suppression devices
- Prediction of platform VIM (understanding discrepancy between model test and in-service results)
- Better definition and modelling of hydrodynamic coefficient

# 4. PROJECT ASSIGNMENT DETAILS AND OUTCOMES

This section presents details regarding each of my Cuneiform project assignments. As introduced in previous sections, both Noble Energy (NE) and Certified Verification Agent (CVA) project assignments are further elaborated by explaining the scope and objective of each assignment, and providing a description of my task and experience as well as a discussion of the assignment outcome.

## 4.1 NE Assignment – Riser Top Termination Qualification (FD #1)

### 4.1.1 Scope and Objective

The scope of this project was to qualify two different service type riser top termination units. These units were designed for use with either simple steel catenary risers (SCR) or steel lazy wave risers (SLWR) in the eastern Mediterranean Sea's deepwater environment. One unit was intended for a gas production import application and the other was for a gas export application. Both units are considered large bore for their respective service use.

The main reason for electing to qualify the riser top terminations was to confirm and prove the in-service performance of the designed units when subjected to the severe project requirements such as large daily pressure fluctuations, internal pressure and temperature, riser large bore size, environmental conditions as well as severe vessel motions if an FPSO or semi-submersible were to be selected as floating host.

As part of the qualification scope each unit was:

- Designed according to project specifications and design data as well as in compliance with applicable codes, regulations, industry standards, recommended practices and norms.
- Fabricated per ITP plan and approved fabrication procedures
- Prototype tested per approved plan, test specification and procedures

The riser top termination unit supplier then issued a final qualification report for each unit tested with details of the testing results, findings and conclusions.

The primary objective was to confirm that the supplier's design met all project requirements by performing a prototype testing. This would help diminish uncertainties and minimize project execution and operational risks due to a premature failure of either of the two type of termination units.

### 4.1.2 Accomplished Tasks and Experience

As mentioned previously in section 2, my final position for this scope was riser lead and technical advisor. Indeed, my position gradually evolved from technical advisory to assuming additional responsibilities due to the oil market downturn and progressive job cuts. It was about halfway through the project that I was asked by NE management to take on the responsibility of the qualification PM (project manager), and, shortly thereafter, I was asked to also perform the duties of the project quality lead during the latter portion of the manufacturing activities and through the remainder of all qualification and testing activities.

These responsibility shifts were chiefly due to oil market downturn, whereby the previous qualification scope manager and the quality lead as well as several supporting individuals unfortunately lost their job.

As part of the riser top termination qualification project, I was responsible for the following technical activities on behalf of NE:

- Provided technical support during design, fabrication and testing of both riser top termination units
- Reviewed and consolidated comments on all design reports
- Held meetings to discuss NE's comments in order to ensure alignment and help expedite response to comments and ensuing revisions to documents as necessary
- Reviewed all fabrication ITP plan and procedures
- Requested that the supplier perform analysis of the prototype as subjected to the accelerated fatigue test conditions (i.e. to model the model) prior to the start of the actual testing. This helped verify the accuracy of the supplier's assumed empirical parameters in their analytical model and to assess their prediction capabilities.

- Multiple site visits to supplier's test facility to witness:
    - Test preparation and setup progress
    - Factory Acceptance Test (FAT) and stiffness tests at elevated temperatures of each unit pre-fatigue and post-fatigue test
    - Final dissection results for each units
- Attended bi-weekly internal meeting
- Participated in risk review and hazard identification

In addition to technical responsibilities detailed above, the following is a description of my managerial and my non-technical administrative duties performed on behalf of NE:

- Coordinated and managed portion of the manufacturing activities and all of the prototype qualification testing program
- Managed the day-to-day qualification test activities of both units
- Reviewed and consolidated NE's comments to all qualification testing specification and procedures
- Ensured that prototype was tested per approved plan, test specification and procedures
- Site visits to supplier's subcontractors fabrication shops for kick-off meetings (KOM) and pre-production meeting (PPM) to ensure project alignment as well as for witnessing ITP inspection points and to follow progress
- Coordinated inspectors and reviewed their weekly reports

- Attended bi-weekly internal meeting
- Set-up regular weekly meetings and teleconferences with supplier to discuss progress, outstanding items, upcoming activities and project schedule
- Provided daily progress update during testing phase to management
- Set up risk review and hazard identification meeting
- Consolidated and submitted comments to supplier's documentations through NE's document control system
- Reviewed and approved contractor milestone invoices
- Coordinating inspectors for witness and hold points per approved ITP (Inspection and Test Plan)
- Reviewed and approved inspector invoices
- Prepared and submitted timesheets

The primary technical challenge for this scope stemmed from the degree of uncertainties with the design and long-term performance of the unit in-service. The supplier has built many successful units to date and had used their past experience to extrapolate their analytical design tools and models to design the two different service type riser top termination units for this NE's project needs and requirements. However, there was a lack of engineering data from a previously qualified and field proven top termination unit with similar or more severe requirements than those for this project.

It was therefore critical from a technical standpoint to develop a thorough qualification program, and carry out tests on a prototype unit from each service type to confirm that both new units were fit for service and would perform as intended.

Indeed, some of the main design challenges considered as part of the qualification activities were the performance of the units subjected to high operating pressure as well as high pressure fluctuation requirements. Special fatigue and strength design consideration were also given to the potential use of FPSO, Semi-Submersible or Spar as likely future deepwater floating hosts. Sensitivities to temperature and marine growth effect were also paramount to confirming the design and performance of both riser top termination units.

In order to ensure meaningful qualification test results and proper interpretation, it is important that special attention is given to the calibration and extrapolation of accelerated fatigue calculation damage methodology. Therefore, Dr. Mekha and I strongly insisted that the supplier analyze the prototype in its test configuration and subjected to the defined test block conditions and loadings as per the qualification test procedure ("analytically modelling the model"). This exercise helped assess the supplier's prediction capabilities and to verify the accuracy of their analytical design models and tools together with their assumed empirical parameters. This was the first time a client had requested them to do this as part of a prototype qualification testing. Indeed, there were great findings from conducting this exercise that benefitted both NE and the supplier.

The qualification goal was therefore to acquire better understanding and insight into the performance of each unit when subjected to project conditions. The reduction of uncertainties would then help minimize and mitigate project execution and operational risks.

Moreover, there were several management challenges encountered and successfully overcome during the execution of this scope. The most prevalent challenges were associated with the management of personnel changes within NE, supplier and sub-suppliers project teams as well as managing the project schedule.

In particular, it was found that the project schedule provided by the supplier as part of their contractual offer was unrealistically tight and aggressive. The supplier's original schedule did not leave any recovery margin from potential and typical issues encountered during manufacturing and testing.

Unfortunately, right from the start of the project, there were some delays in securing the forgings through the sub-supplier which placed a strain on the schedule. The schedule delay got further exacerbated during manufacturing given that some forgings had to be re-heat treated and tested. The prototype test sequence also had to change due to a miss-machining problems with a major component of one of the two units. The various delays in schedule and the supplier's inability to recover to the unrealistically tight schedule that they had originally offered caused great consternation and stress for both the NE project team as well as the supplier.

Falling behind the original schedule only worsened with delays caused by personnel changes and lay-offs, and due to newly imposed work hours at supplier and sub-supplier facilities as a direct result of the oil market downturn.

After a few personnel changes within NE's organization, I was assigned as PM for this project. This was in addition to my previous role as the technical advisor. Subsequently, I worked with the supplier to develop a revised aggressive but realistic schedule. This helped greatly with team morale and general motivation. The supplier was actually able to stay ahead of the revised schedule by a few days and recover from a few test equipment failures and from a small delay in the delivery of a specialized test tool coming from a different rental job offshore. The supplier did a good job in keeping backup and spare test equipment such as heavily used pumps and a clever system for easy switch outs.

As part of these workforce changes, I also had to perform the duties of the quality coordinator, whereby I had to arrange for our inspector's attendance to inspection activities per project ITPs. It is important to note that for most inspection activities only one company representative would be assigned and present to help reduce costs. As such, for some of the critical activities where our material specialist would need to be present, we avoided sending our inspector. Similarly for some of the testing activities that needed technical expertise, I ended up attending alone on behalf of NE.

### 4.1.3 Outcome

Both riser top termination units were successfully tested and qualified for use within a defined range of challenging design conditions and parameters.

It should be noted that originally this qualification program was going to run in parallel with manufacturing of the actual production units intended for service. There was therefore limited time between assessing the outcome of the qualification and implementation of the findings to improve the design and performance of the production units. Specifically, in case of a negative outcome of the qualification testing this would have limited NE's and supplier's options to make necessary design or even fabrication remediation. Rather, it would have only allowed for a premature but costly planned in-field change-out. Luckily the project as a whole was suspended and placed on hold and NE's management had the foresight to continue with the qualification efforts. This has allowed NE to reduce uncertainties and given that the program was successful and both units met all project requirements no design or fabrication changes were found to be necessary. In case the qualifications were found to have shortcomings, NE would have had the time to fully address the shortcoming upfront with minimal costs and schedule delay prior to placing the order for production units.

Thus, one great lessons learned is for companies to keep ahead of the needs for upcoming field developments and invest in their future by being involved with qualification and R&D efforts as early as technological gaps are identified.

The role of upper management from both company and supplier to set project expectations and ensure alignment prior to the start of the project is found to be crucial for fast track and critical components.

Similarly, company's management having been invited to the KOM with supplier's sub-contractors was also very helpful to get safety, quality and schedule alignment. In general, providing the sub-contractors with a view and understanding of the importance of their contribution to the overall project is found to enhance their motivation, provide them with a greater purpose and a sense of ownership. It is important for every player to feel part of the same team and be able to share in the overall project success.

To this end, KOMs and PPMs help fulfill some of the fundamentals of good project management by allowing the introduction of project team members and the open discussion of project scope, requirements, schedule and expectations. It is also an opportunity to clarify queries and concerns. At this occasion the rules for proper communication routes can be established. In general, it is highly recommended that sub-contractors communicate through the supplier. This may be a bit painful at times but it allow the supplier to always be in the decision loop and avoid misunderstandings or commercial and legal gaps to be discovered later. It is also recommended that key contact person(s) be identified within each project team and that they be the facilitator of communications that they are ultimately responsible for. There are indeed many contributing factors to project execution success such as designation and establishment of points of contact, clear identification of roles and responsibilities, and clear communication and protocol.

All steps of the testing were performed and monitored carefully as detailed in the approved test specification and procedure. Potential hazards and mishaps were identified and risks mitigated to avoid a major schedule setback in the test program. Indeed the potential scenarios for test temperature run-off was assessed and addressed carefully. To this end failure scenarios and what if situations were analyzed and preventive actions were put in place.

Personnel lay-offs and workforce reductions as a result of the oil market downturn affected all project teams in terms of project continuity, change of responsibilities and workloads both in terms of technical and non-technical duties.

Unfortunately, during the initial phase of test start-up the supplier had a major change in its specialized test personnel. This presented a particular managerial challenge requiring me to prioritize the need to maintain personnel safety and avoid the risk of a testing mistake over test schedule while allowing the new testing personnel sufficient time to develop the necessary familiarization with the test procedure and training with test software, setup, hardware and equipment. It was important to realize that pushing the test personnel before they were ready in order to maintain the test start date could seemingly avoid a week of delay, however the risk of exposure to a testing mistake that could potentially result in a safety incident or a project setback with a major schedule delay would be unacceptably high.

As a manager and engineer it is crucial to understand the risks to be able to have the correct judgement and take the right decision. Performing regular risk reviews and hazard identification can significantly aid to this end. Safety and quality needs to be always considered when an activity is being expedited.

As discussed earlier, it is important to work with an aggressive but realistic schedule in order to set correct expectations. However, contractors and suppliers do not always provide such schedule. In the case where their schedule has excessive float, project activities tend to prolong unnecessarily and a lack of urgency and priority may set in and manifest itself. On the other end of the spectrum, a very aggressive schedule with unrealistic goals will have the tendency of inducing undue stress on the project teams. It may also demotivate the teams and thus be counter-productive. Furthermore, activities that are done well and quickly will not stand out and appreciated which may have a demoralizing affect. Unrealistically tight schedules also entice risk taking and cutting corners with the effect of reduced and jeopardizing project safety and quality.

A good manager and management strategy will ensure that schedules are thought through and realistic. Thus creating a win-win situation for all parties and a source for positive motivation, morale, appreciation and feedback cycle.

In summary, this project presented several technical and managerial challenges which were successfully overcome. The valuable information and knowledge obtained from the qualification testing effort certainly helped reduce the prior level of design uncertainties and diminish the overall project risk. This understanding and insight will help support NE managers in their decision-making process.

## 4.2 NE Assignment – Delivery of Production Riser System and Spare Riser Top Termination Units for GOM Field (FD #2)

### 4.2.1 Scope and Objective

This project, located in the GOM, was a fast-track field development to help extract and produce oil from two major NE field discoveries. Both nearby discoveries were developed by NE as a dual-riser tie-back to an existing floating platform host, a semi-submersible. As part of the tie-back agreement with both platform owner and operator, two riser porches and three umbilical I-tubes were designated and assigned to NE.

The scope of this NE project assignment included the design, fabrication and installation of two production steel catenary risers as well as the delivery of two spare riser top termination units.

The additional scope comprised of leading and coordinating the independent design, fabrication and installation verification work for the two production risers and the gas lift umbilical that was performed by a third party engineering company. Indeed, the risers and gas lift umbilical deliveries were critical scopes to the realization of this strategic and major project for NE.

The primary objectives were the following:

- Lead riser design scope as well as the design, fabrication and delivery of the riser top termination units on behalf of NE

- Review riser installation procedures and provide technical assistance during riser installation
- Help resolve riser related internal and external interfaces
- Confirm that risers and gas lift umbilical met all regulatory and project requirements, and are fit for purpose
- Lead production riser and gas lift umbilical design, fabrication and installation CVA scope on behalf of NE
- Coordinate regulatory requirement and review CVA submittals
- Review ITP and coordinate with project quality lead
- Manage schedule and budget and ensured on-time and on-budget riser delivery

### 4.2.2 Accomplished Tasks and Experience

This project was in its execution phase with particularly fast-track and schedule critical delivery requirements. For this assignment my position was riser lead and technical advisor.

As part of this major GOM field development project, I was responsible for the following technical activities on behalf of NE:

- Provided technical support for the riser design scope as well as for the design, fabrication, testing, delivery and installation of the riser top termination units
- Provided technical support for the production risers and gas lift umbilical design, fabrication and installation CVA scope

- Helped resolve internal and external riser interfaces by providing responses to various riser related queries and interfacing with multiple teams and parties such as the riser contractors, third party verification engineering company, installation contractor, topsides facilities, floating hull and mooring, controls, systems, subsea infrastructure, reservoir, flow assurance, materials, welding, quality, health and safety, regulatory and operations teams.
- Extensive involvement in review of riser related activities. Reviewed and consolidated comments on riser design reports as well as riser related technical reports and procedures
- Assisted NE's installation lead in reviewing riser installation procedures and attending technical meetings.
- Provided technical and logistical assistance to offshore installation campaign as well as to re-installation of the riser closing spool after issues were found with trapped pig
- Coordinated regulatory requirements and reviewed CVA submittals. Provided technical support in obtaining BSEE's approvals for the production risers. (BSEE is an agency under the United States Department of the Interior (U.S. DOI))
- Held meetings to discuss NE's comments in order to ensure alignment and help expedite response to comments and ensuing revisions to documents as necessary

- Provided technical support for the design, fabrication and testing of spare production and future water injection riser top termination unit forgings. Also provided feedback during spare production top termination fabrication and FAT (factory acceptance testing) based on lessons learned from testing of initial units.
- Participated in internal and external technical meetings
- Participated in risk review and hazard identification
- Participated in project close-out Lessons Learned session

In addition to technical responsibilities described above, the following is a record of my managerial and my non-technical administrative duties which were performed on behalf of NE:

- Coordinated and managed the riser design scope as well as for the design, fabrication, testing, delivery and installation of the riser top termination units
- Coordinated and managed the production risers and gas lift umbilical design, fabrication and installation CVA scope
- Coordinated riser internal and external interfaces
- Facilitated CVA review of riser fabrication and installation databooks
- Coordinated CVA scope and assisted NE's regulatory team in obtaining BSEE's approval for the production risers.
- Supported and assisted the delivery of spare production and future water injection riser top termination unit forgings

- Site visits to supplier's subcontractors fabrication shops for KOM and PPM meetings to ensure project alignment as well as for witnessing ITP inspection points and to follow progress
- Consolidated and submitted comments to riser contractor documentations through NE's document control system
- Set-up regular meetings and teleconferences with riser contractors to discuss progress, outstanding items, upcoming activities and project schedule
- Provided weekly riser update to management
- Manage schedule and budget to ensure on-time and on-budget riser delivery
- Reviewed and approved contractor milestone invoices
- Reviewed and approved inspector invoices
- Managed the closeout of initial project phase
- Participated in Lessons Learned session
- Prepared and submitted timesheets

As explained previously, the tie-back host was an existing oil producing floater in the GOM. A fairly distinctive arrangement that added greatly to the overall technical and managerial challenge of this project derived from the fact that the owner and operator of the platform were different entities. This created an additional layer to the complexity of the interfaces, decisions, agreements and communication protocol.

From a technical standpoint the design of the steel catenary risers (SCR) and top termination units had a few distinctive challenges. Indeed, the vessel motions due to wave, wind and current (in particular VIM) were found to present particular strength and fatigue design challenges for the SCR solution.

Furthermore, shortly after coming on board this project, I reviewed the riser design basis and discovered that the metocean data supplied by platform owner and operator were out-of-date. Thus, I highlighted the need and with NE's management approval, worked with a specialized Metocean Company to obtain a revised and updated metocean data for the design of NE's new risers and new umbilicals. As anticipated, the site metocean data had become more onerous due to revised wave and wind criteria that accounted for hurricane events that had happened around and subsequent to the platform's design and installation date.

During the course of several discussions with the platform owner's technical experts, it was confirmed that in fact the offshore facility had undergone re-analysis and risk assessment, based on additional regulatory requirements that were introduced after the platform's original design date. These additional regulatory requirements had been issued to all GOM offshore operators in order to verify and assess the capacity of their offshore production facilities to resist the increased environment criteria in the GOM based on the strong hurricane activities around 2004-2005 in particular with Hurricanes Ivan, Katrina and Rita.

As part of the discussions with the platform owner it was agreed that the vessel motions required as input for the riser and umbilical analysis would be provided using revised metocean criteria. Importantly, the riser and umbilical designers would then provide the interface loads for the platform owner to perform strength and fatigue verification of NE's riser porches and receptacles, umbilical I-tubes and platform/hull tie-in supports.

Indeed, the use of an outdated metocean criteria for the design of NE's new risers could have produced a major risk and setback to the project development and permit approvals as well as to project cost and schedule.

It is also important to note that initially all project plans and contracts (design, fabrication and installation) were based on the tie-back of only one of the two discoveries. This given that the drilling efforts and the reservoir characteristic and parameters of the second discovery were still under evaluation. Hence, the final decision by NE and its partners to combine and tie the second discovery was made late. By the time of that decision, many of the major equipment contracts had been signed, design efforts already well underway as well as platform agreements and installation contracts negotiated.

This late decision introduced a major impact in finalizing the flow assurance data with cascading effect on other scopes. It also generated a considerable effort in design re-verification, and management of this design re-assessment work. New design conditions and parameters such as increased design pressure and temperature, changes to the production profiles and different field layout including change to the assigned riser platform porch all had to be checked and interface repercussions had to be managed and addressed. It is important to highlight that an initial high level assessment had been performed to mitigate some of the uncertainties and to reduce project risk until the design was fully completed at a later date.

To help with the riser in-field behavior and performance due to strong loop current challenge, I made the suggestion to the riser designer to consider using fairings instead of strakes as VIV suppression device over the top portion of the riser that was subject to high loop current. The riser designer checked the riser design performance with my suggestion and implemented it into their final design.

During the early phase of project execution, as part of interface design resolutions, NE discovered major limitations of the host platform for the riser pull-in and installation. A result of limited cranage and pull-in winch's deck support capacity, the riser had to be installed first (1$^{st}$) end, meaning that the installation vessel first hands the host designated riser end to the floating platform and then lays the riser away from the host until the subsea end is placed on the seafloor. SCR's are often installed using the second (2$^{nd}$) end method (opposite order to the 1$^{st}$ end) which allows a better control of the riser touch-down zone (TDZ) and its hang-off angle which are important parameters affecting the riser performance. There were also several onerous constraints and limitations for the deployment, pull-in and installation of the riser top termination unit which was a flexible joint. Due to the riser 1$^{st}$ end installation method, additional design and installation considerations were required to mitigate the risk of damage to the flexible joint. I worked closely with the riser top termination supplier and our installation group to develop, fabricate and test two anti-rotation installation tools that were ROV (Remotely Operated Vehicle) removable which were then successfully used during the riser installation.

In addition, the weather during the riser installation presented a significant challenge due to strong and persistent loop currents in the vicinity of the host platform.

The riser installation had to be delayed until the weather improved and an adequate installation weather window became available. Several meetings were held with the installation vessel, host vessel, project teams and riser top termination supplier to assess installation parameters and limitations based on weather and platform offsets and motions in the field. Depending on the strength and direction of loop currents it was noted that the platform would experience VIM motions.

Another unique aspect of the project was the requirement for an independent certified verification of the gas lift umbilical by a CVA. This requirement had not been clear in the past and there appeared to be no industry precedence when checked with major umbilical designers, suppliers, the project's riser CVA as well as with NE's regulatory advisors. To mitigate the project regulatory risk until BSEE had time to review and confirm if CVA would be required for a gas lift umbilical, NE took the clever initiative to start an independent design verification. NE utilized my previous CVA experience and that gained from leading the project's two production risers CVA. I was assigned as lead for the coordination of the gas lift umbilical CVA effort along with the CVA work that was ongoing for the production risers.

There were quite a few management challenges encountered and successfully overcome during the execution of this scope. The most prevalent challenges were associated with the management of interfaces, supplier and sub-suppliers project teams as well as managing the project cost and delivery schedules.

The coordination of external and internal interfaces was of particular challenge with multiple contractor scopes inter-related and inter-dependent both technically and schedule wise. An efficient system for timely resolution of internal and external riser interfaces was therefore key. I assisted NE's interface manager with gathering responses to various riser related queries and facilitated the exchanges between the riser contractor and other parties such as a third party verification engineering company, riser installation contractor, floating hull and mooring, topsides facilities, controls, systems, subsea infrastructure, reservoir, flow assurance, materials, welding, quality, health and safety, regulatory and operations teams.

In particular, the riser installation interfaces presented quite a challenge given that very large number of companies with multiple participants were involved. Clear definition of responsibilities, effective communication, in addition to timely identification and management of required information were essential to the resolution of each interface.

Managing the delivery times for this project were crucial to meet the original contractual installation date. Unfortunately, the riser installer was not forthcoming on the actual installation date. In order for NE to avoid missing the agreed contractual date and potentially be penalized, the riser delivery dates were kept very aggressive. The installer did not confirm the significant delay in their installation vessel's availability for the start of the offshore installation campaign until a much later date when most delivery scopes were near completion. After confirmation of the delayed installation start date, the schedule of some of the components was reviewed to relieve some of the activities that would put the supplier and sub-supplier under very intense pressure with increased personnel safety risks or those requiring working overtime and outside of their normal shifts or on Sundays and holidays. The second consideration was to help reduce the risk of damage to components. The final assembly of some components was purposely delayed to allow the individual components to be stored indoors in a secure and protected location, rather than be exposed for an extended amount of time to external elements in some outdoor yard once assembled due to storage size, space or time limitations.

A realistic yet aggressive schedule was agreed to and successfully maintained based on the two schedule considerations stated above while averting risk of a delay by ensuring that the final delivery was agreed to be completed sufficiently in advance of the installation need date.

It was also very important for me and NE to keep an honest and an open communication with the riser suppliers on real need dates once they were officially confirmed to establish trust. Indeed, it is important to ensure that the same supplier trusts and believes you when you again state that there is urgency on a future project.

Moreover, a good material traceability and sparing philosophy are key to the success of any offshore project. For this project these good practices helped alleviate schedule delay risk to the project. I worked closely with the project material coordinator and suppliers to ensure all material had proper traceability and documentations. In particular all shipments had to be accompanied with the following documentation as a minimum:

- Packing List / Commercial Invoice to include item descriptions, part numbers, serial numbers, monetary value, etc…
- Latest drawing with stated dimensions and weights
- "Ships From" address and supplier contact

- “Ship To” address and receiver contact
- Any additional information required for transportation permitting
- Applicable Storage and Preservation Procedure
- Applicable Shipping, Handling, Tie Down Procedure

### 4.2.3 Outcome

The two production risers have been successfully installed and are now operational and producing oil back to a tie-back floating platform host in GOM. The spare production riser top termination units and the spare long-lead forgings were delivered and placed in NE’s storage facility. This project was executed safely, on-time and on-budget.

The design and engineering of these dynamic structures require a high level of expertise and detailed understanding of the internal and external environment. This understanding and expertise is imperative to ensure a safe and robust design that provides the proper level of health, safety and protection for the offshore personnel, the population and the environment. The avoidance of incidents through proper riser design also helps safeguard the offshore asset and the interest of all stakeholders. Correct hazard identification and appropriate risk evaluation is of paramount importance.

From a managerial perspective, it was very important for management to establish clear management processes and protocols in preparation of a project execution kick-off. Often training sessions are created and put in place to help ensure project team members’ familiarity, alignment and bringing them quickly up to speed with various procedures and goals. Those training sessions that pertain and related to the particular work scope of a contractor or supplier can then be selectively offered to them shortly after contract kick-off. As such, it was quite surprising when management made the decision to change the document control system and process in the middle of project execution. The previous document control system was not perfect, but nor was its replacement. Indeed, after the change everyone on the project struggled with access and learning curve on a new software. As such the flow of documents which is critical to the execution of a fast-track project was negatively affected. The efficiency in "official" reviews and responses through the document control system was delayed and was inefficient.

As discussed, a material traceability and sparing philosophy are key to the success of any offshore project by helping alleviate schedule delay risk and reducing long-lead delivery time. To this end, two spare riser top terminations were ordered whereby one unit is intended to serve as a replacement back-up to the in-service production units. For the second spare unit only some of the forgings were secured and rough machined. The primary objective was to reduce the delivery time given that the preliminary flow assurance analysis showed a strong likelihood for need of a water injection riser to help maintain reservoir pressure to enhance oil recovery and production rates during the life of the field. As such it is important for operators to have a good forward vision and good specialists that could guide them in making the right decisions for optimal efficiency.

NE project management did an excellent job with setting project expectations and helping ensure alignment with contractors and suppliers prior to the start of the project. Management was generally present during major contract KOM's. Reports on progress from every lead were required on a weekly basis to the Subsea Manager and monthly progress was required to upper management.

For the delivery of the riser top termination units, I requested that a KOM and PPM be held with sub-contractors and sub-suppliers to introduce project team members and points of contact, as well as discuss project scope, requirements, expectations and schedule. It was also an opportunity to clarify queries and concerns as well as providing sub-suppliers and sub-contractors with an overview of the overall project and an understanding of the importance of their contribution. This helped provide all team members with a greater purpose, a sense of ownership and interest, enhanced team motivation and often better than initially proposed delivery schedules.

The principal of open and honest communication with the supplier helped establish a trust and a cooperative effort. As a team with a common goal, the supplier's project manager and I were able to overcome many of the schedule challenges. It must be noted that the supplier PM had excellent work ethic and leadership when engaging the sub-contractors and sub-suppliers.

The schedule was quite aggressive due to the initially set installation target date, but achievable with some work carried out during night shifts and on weekends. Once it was confirmed that the installation schedule was delayed, the schedule was reviewed and some of the pressure relieved. As explained in the previous section, having the component expedited to be assembled and delivered over 6 months ahead of installation schedule would increase the likelihood of damage, cause logistics and storage issues and pose a greater safety risk. The efforts to strategically re-assess the schedule was well received by all affected parties.

As part of the close-out of this project, a detailed lessons learned was performed which included feedback from project contractors and suppliers. The goal of this exercise was to gather valuable technical and non-technical lessons to help NE document, transfer and apply this knowledge to its future field developments. These lessons learned, if implemented well, could improve execution efficiencies, generate great cost savings, increase project quality and safety, and allow for better definition of project requirements by reducing technical and managerial gaps.

Indeed, the management and project coordination activities were key to the project's overall success. The challenges for the execution of this project and the demands of my assigned scope provided me with a greater understanding of the significance of teamwork, communication, management, leadership as well as organizational structures and cultures.

Moreover, I had the great opportunity to meet and work with many knowledgeable and experienced individuals on this project. This project experience has enabled me to acquire and develop new technical and non-technical competencies.

## 4.3 NE Assignment – HPHT GOM Field Tie-back (FD #3)

### 4.3.1 Scope and Objective

This high-pressure high-temperature (HPHT) tie-back oil field is also located in the GOM. This project was at an early conceptual phase and there were several platform candidates considered as an option for tie-back host by NE. Various negotiations were ongoing between NE and each platform owner and operator. Several platform host candidates were jacket structures located in shallower water and one was a floating type in deeper water.

The scope of this project assignment consisted of performing a comprehensive conceptual level field development study for a 15ksi HPHT riser tie-back system. Both steel and flexible riser options were assessed for each host option in terms of design, fabrication, installation and operation feasibility as well as for reliability, risk, cost and schedule.

The primary objectives of this project were:

- Concept development and evaluation of a 15ksi production riser tie-back
- Evaluate technical and economic feasibility of concepts
- Identify and address important riser interfaces
- Develop schedule and estimate cost
- Assess solution reliability and risk

### 4.3.2 Accomplished Tasks and Experience

For this project in the GOM, I worked on the project as the riser lead and technical advisor involved in the concept development and evaluation of 15ksi HPHT production riser tie-back solutions to several potential host options in GOM.

I had the great opportunity to be part of a team of project leads, each lead was a specialized expert in their respective field.

NE management had judiciously selected expert individuals from two of their recent major GOM projects in order to fully draw from their knowledge and latest experience. I had just participated in one of the recent projects as the riser lead and technical advisor (described in the previous section). The second recent project was also in its final phase pending completion of installation.

As part of this GOM concept development study, I was responsible for the following technical activities on behalf of NE:

- Technical lead for 15ksi production riser tie-in study
- Attended meetings to discuss host options and riser solutions for various hosts in different water depths
- Reviewed all available platform drawings and field layouts to evaluate riser solutions and installation options
- Assessed both steel and flexible riser solution options for each host in terms of design, fabrication and installation feasibility

- Identified and helped address primary internal and external riser interfaces necessary for conceptual level evaluation
- Prepared design inputs and supply scope for flexible pipe feasibility assessment
- Followed-up with queries from flexible pipe designer and supplier
- Facilitated the feasibility and cost evaluation of flexible pipe solution for riser and flowline tie-back options
- Reviewed flexible pipe preliminary design for risers and flowlines as well as delivery and installation cost proposal estimates from flexible supplier
- Assisted with schedule and cost estimates
- Assessed steel versus flexible solution reliability and risk

My managerial and non-technical administrative duties performed on behalf of NE as part of this concept study are listed below:

- Coordinated and managed the preliminary and conceptual engineering work scope carried out by flexible pipe supplier for riser and flowline tie-back options to host candidates
- Coordinated the feasibility and cost estimate scope for the flexible riser and flowline solution
- Coordinated and facilitated riser internal and external interfaces
- Held teleconferences with flexible pipe supplier to discuss scope and progress
- Attended project meetings

- Prepared and submitted timesheets

One of the main challenges for the project team was to evaluate the technical and economic feasibility for the development, considering each platform candidate as a tie-back host option. At the time of this project, cost saving and cutting was a big priority. The project team was also given a limited time and budget to complete this evaluation.

For the riser scope, the high pressure and high temperature production fluid characteristics were a great technical challenge for both steel and flexible riser pipe solutions.

Other design challenges were related to the limited availability of information on the host candidates at the time of the study. The existing condition and state of spare pull-tubes, I-tubes, and riser hang-offs were insufficient for detailed assessment and design evaluation. Furthermore, some of the platform constraints such as access for installation and commissioning as well as riser payload constraints for the floating host were not known. The cost and risk impacts from these unknowns needed to be evaluated and accounted for in the final decision making process.

The primary managerial challenge for my scope was to coordinate and facilitate riser internal and external interfaces as well as manage the preliminary and conceptual engineering work scope carried out by the major flexible pipe supplier for riser and flowline tie-back options to host candidates.

### 4.3.3 Outcome

The riser feasibility phase was successfully completed. A base and alternative solutions were defined. The next phase of the project is anticipated to start after a successful drilling program and based on the state of the oil market.

In terms of design challenge, a 15ksi rated flexible pipe solution satisfying the bore size required for flow assurance was pushing the technological boundaries in terms of qualified and field proven in-service pipe.

It is also noteworthy that a recent 15ksi project with a smaller bore size had been manufactured and installed in GOM but had failed due to a leak during in-field acceptance test and had to be replaced by steel pipe. Since this failure, the flexible suppliers contend that they have identified the root cause of failure and the problem has been addressed.

The high design pressure and pipe bore size based on the flow assurance requirement also presented a technical and economical challenge for a steel pipe solution. Depending on the pipe size and grade, particular attention would need to be given to the weld scope, installation and their associated cost.

Hence, the determination of technological gaps was crucial. For a feasible solution, the concept selection would need to consider cost and schedule as well as solution reliability and risk.

Other design challenges were related to the limited information availability for the host candidates at the time of the study. The existing condition of some of the spare pull-tubes and I-tubes was not sufficient for full evaluation. Therefore, alternative installation concept solutions were defined assuming that these structures may not be usable for NE's tie-back risers. As part of this exercise, additional platform inspections and verification were recommended for better definition in the next project phase.

It is important to highlight that NE management had wisely selected expert individuals from two of their recent major GOM projects. NE was therefore able to fully draw from the team's knowledge and latest experience, as well as transfer and implement the applicable lessons learned from past and recent projects.

Due to the oil market downturn, this project looked very closely at economic feasibility first, and then project effort was placed on minimizing project risk and on selecting the most cost effective solution. Indeed, prior to the market downturn, with high oil prices project economics was typically less of an issue especially for big oil fields. It was therefore very effective that NE had recent field development cost data to help with more accurate cost estimates.

It is important to highlight that minimizing project risk often equates to an increased upfront cost and CAPEX. The current market downturn and the focus on cost cutting, to help project economics, may have a tendency to push organizations toward minimizing CAPEX which often pushes for riskier solutions. Hence, if a project team lacks necessary prudence and judgement, and solely opts for the cheapest solution, then they may increase the project risk exposure, thus increase the likelihood of a failure and place undue burden on both project CAPEX and/or OPEX.

In an effort to reduce cost, project teams need to ensure that experienced contractors with proven quality and safety records are selected. A great practice by NE was to develop a list of approved and qualified contractors and suppliers that met stringent safety and quality requirements. NE would then select the contractor based on the best bid offer.

## 4.4 NE Assignment – Riser Design Feasibility and Selection in the Eastern Mediterranean Sea's Deepwater Sites (FD #4)

### 4.4.1 Scope and Objective

This project assignment combines my involvement on two of NE's new major developments located in the eastern Mediterranean Sea. The first development had advanced from feasibility evaluation and concept selection through FEED and into execution phase before the entire project was placed on hold and suspended primarily due to regional issues and a few geo-political roadblocks.

During my internship, the suspension was lifted, however based on re-evaluation of field development economics, state of current market and regional geo-politics, it was decided in favor of relocating the tie-back host closer to shore.

The second prospect I worked on was also in the eastern Mediterranean Sea. This prospect was progressed through an advanced concept selection phase.

The primary objectives of these two field developments were:

- Concept development and feasibility evaluation of riser tie-back solutions
- Evaluate riser and floating hull selection

- Evaluate optimal location for the tie-back host with budgetary and schedule comparison of initial phase of development versus full field development
- Evaluate use of flexible versus steel riser, flowline and jumper
- Evaluate technical and economic feasibility of concepts
- Identify and address important riser interfaces
- Develop schedule and estimate cost
- Assess solution reliability and risk
- Prepare basis of design document, define scope of works and client specification
- Prepare for tendering and bid evaluation

### 4.4.2 Accomplished Tasks and Experience

For these eastern Mediterranean Sea field development assignments my position was riser lead and technical advisor. I was involved in the concept development and feasibility evaluation of both projects and through the first project's restart phase after suspension of the execution phase.

As part of these field development projects, I was responsible for the following technical activities on behalf of NE:

- Riser lead and technical advisor for the riser design feasibility and selection in the eastern Mediterranean Sea's deepwater development sites

- Client’s riser technical lead for hull and riser selection studies.  Worked closely with engineering contractor’s riser team to ensure that all aspect of riser design such as strength, wave/VIV/VIM fatigue, interference and installability were verified.
- Heavy involvement in review of riser related activities
- Reviewed and commented on various riser technical study reports including the final summary report that served for NE management decision-making
- Participated in several risk workshops in preparation of presentation to upper management
- Provided revised riser configuration for a shallower floating host location, and updated installation and in-service riser and umbilical loads for the new host location site
- Produced and updated basis of design, defined scope of works and client specification documents for the riser studies and riser detailed design execution scope in anticipation of the next phase of project
- Provide technical support for resolution of riser related interfaces with various parties and multiple teams such as riser contractor, flexible suppliers, riser top termination supplier, flow assurance, topsides, hull and mooring, controls, systems, operations, materials, quality, health and safety teams.
- Assisted in revising and updating the riser, umbilical and floating host interface document

- Furthermore, assisted subsea team in evaluating flexible versus steel riser, flowline and jumper solutions.
- Requested quote inquiries regarding supply of flexible riser, flowline and jumper alternative solution. Followed-up with queries from flexible pipe designers and suppliers
- Facilitated the feasibility and cost evaluation of flexible pipe solution for riser and flowline tie-back options
- Responsible for preparing decision package to compare (pros/cons) of rigid versus flexible jumpers. Provided project specific parameters and input data to primary flexible pipe manufacturers to obtain qualified and field proven design as well as budgetary and schedule information.
- Researched and investigated the current state of the art on flexible pipe as well as failure modes and history to allow better decision making based on solution risk and reliability.
- Attended OTC (Offshore Technology Conference) technical sessions in particular those related to challenges and advancements in flexible pipe technology
- Investigated the latest on bounded flexible pipe as alternatives to unbounded flexible and rigid pipe solutions
- Assessed steel versus flexible solution reliability and risk
- Assisted with necessary input for manufacturing and weld qualification of "seamless" and "DSAW" pipe to project specific conditions and requirements

- Attended many internal and external technical meetings
- Attended several management meetings to explain and clarify technical details as related to risers and top termination units
- Participated in risk review and hazard identification
- Provided response to peer review meeting queries
- Participated in project Lessons Learned sessions

My managerial and non-technical administrative duties performed on behalf of NE as part of this concept study are listed below:

- Coordinated and managed the riser design feasibility and selection studies. Worked closely with engineering contractor's riser team to ensure that all aspect of riser design were verified.
- Reviewed and commented on cost and schedule study reports including the final summary report that served for NE management decision-making
- Verified contractor's NPV (net present value) penalty findings for delayed project and deferred production
- Participated in several risk workshops in preparation of presentation to upper management
- Helped coordinate riser related interfaces with affected project teams and third parties such as riser contractor, flexible suppliers, riser top termination supplier, flow assurance, topsides, hull and mooring, controls, systems, operations, materials, quality, health and safety teams.

- Worked closely with project team and document control to produce and issue project documentations such as basis of design, scope of works, client specifications and decision packages
- Issued quote inquiries and facilitated the feasibility and cost evaluation of flexible pipe solution for riser, flowline and jumper options
- Assisted with development of schedule and cost estimates as well as with the reliability and risk assessment of steel versus flexible solutions.
- Attended project meetings and provided progress updates to management
- Set-up regular meetings and teleconferences with riser contractors to discuss progress, outstanding items, upcoming activities and project schedule
- Managed schedule and budget to ensure on-time and on-budget riser feasibility scope
- Consolidated and submitted comments to riser contractor documentations through NE's document control system
- Reviewed and approved contractor milestone invoices
- Prepared and submitted timesheets

There were several technical challenges that had to be resolved and overcome for this scope. Identification of interfaces, risk and technological gaps was vital to feasibility assessment and concept development.

The fatigue and strength performance of the large 20-inch gas export steel risers hanging off an FPSO in the eastern Mediterranean Sea environment were a particular design challenge. This became an even greater design challenge when the host location was moved into a shallower water depth of approximately 1200m for one of the two field developments.

During the hull and riser feasibility studies, all aspects of production and gas export steel riser design such as strength, wave/VIV/VIM fatigue, interference and installability were successfully verified. Indeed, steel riser combination with FPSO and Semi-submersible presented a greater design challenge than, for instance, a Spar.

A feasible riser configuration was successfully determined for each host type. For the host selection, the riser feasibility or cost was therefore not the primary nor the limiting factor. The final floating host selection was based on the project development's overall cost, schedule and risk.

For the hull selection study, particular design considerations were also required to address safety requirements for an offshore gas production facility. NE had a safety expert lead dedicated to verifying that contractors took necessary safety measures in platform orientation, topsides layout, living quarter placement, module location, equipment arrangement, and platform pipe routings. These arrangements greatly affect the placement and tie-in location of the production and export risers. It is highly recommended that this interface be discussed during the early stage of the project to allow for safe and optimal hang-off position for risers.

The top termination unit for the steel riser option was also of particular challenge for both the gas export and production risers. Both titanium tapered stress joints (Ti-TSJ) and flexible joints (FJ) were evaluated. The limiting factor for the Ti-TSJ when fixed to an FPSO host at the project sites in the eastern Mediterranean was the taper overall length and heavy thickness. The Ti-TSJ's length could be dealt with but the tapered wall thickness would require several extremely thick intermediary circumferential welds along the body of the titanium taper. The weld thicknesses were well beyond any qualified and proven titanium weld thickness in the offshore industry. The challenges with the FJ were successfully addressed and details of the qualification effort are provided under FD #1 in Section 4.1.

The feasibility of the in-field flexible riser, flowline and jumper was also carried out. The project requirement for large pipe bore sizes in combination with demanding flow parameters such as high pressure and high gas velocity were close to or beyond the upper bound limit of flexible suppliers. At the time of queries, several of the major flexible suppliers did not have the desired project pipe size qualified.

As part of the flexible riser, flowline and jumper feasibility both unbounded and bounded flexibles were looked at. The bounded pipe solutions and market had made a significant technical progress but none were yet qualified for use and project consideration. As mentioned, even amongst the unbounded flexible suppliers only a few had qualified product to meet all of NE's project requirements and only one had theirs field proven.

I was responsible for preparing a decision package to compare the pros and cons of rigid versus flexible jumpers. As part of this task, I prepared and provided project specific parameters and input data to primary flexible pipe manufacturers to check for a qualified and field proven design and obtain budgetary and schedule quotes. I also researched and investigated the current state of the art on flexible pipe, as well as its failure modes and history to allow better decision making based on solution risk and reliability.

Moreover, important non-technical and managerial challenges for this scope were to coordinate and facilitate riser and jumper internal and external interfaces, in addition to managing the various engineering work scopes carried out by the riser engineering contractor as well as the flexible pipe suppliers' feasibility evaluations for use of flexible pipe for the project risers, flowlines and jumpers.

I also had multiple interaction with the pipeline lead and material specialist to assist with necessary input for project specific seamless and DSAW pipe manufacturing and fatigue qualification testing. The objective was to help evaluate, qualify and select pipe manufacturers and best pipe solutions for the large export pipeline.

For the riser pipes, the preference was to use seamless pipe with special consideration given to pipe manufacturing tolerances before and after pipe end machining. Indeed, for riser fatigue performance, installation using the reeling method, and engineering critical assessment (ECA) for flaw acceptance and flaw growth rate, it is critical to limit the pipe Hi/Lo.

For the large 20-inch gas export riser pipe, several technical discussions had to be held with leading specialized offshore oil and gas pipe manufacturers, to ensure the tolerance requirements were understood and addressed. In summary, the pipe manufacturer had to add an additional step to their typical manufacturing process for the 20-inch gas export pipe. This additional step was not required for the project's smaller size production riser.

The timely identification and resolution of external and internal riser interfaces was key to managing the schedule and budget of the riser feasibility scope and ensuring the work was completed on-time and on-budget. Effective communication, clear definition of responsibilities and knowledgeable team members were fundamental to expediting the resolution of interfaces.

For the hull and riser feasibility and selection study, close attention was paid to economic feasibility in combination with project schedule and risk evaluation. Options with show stoppers or significant feasibility issues were eliminated. For the remaining feasible options, a detailed risk assessment was conducted and major differentiating risks analyzed and quantified. A risk adjusted net present value (NPV) was then calculated for the remaining feasible options to help select the best option. I participated in several option identification and risk assessment workshops with the hull/riser selection contractor as NE's riser technical advisor.

### 4.4.3 Outcome

The riser feasibility and selection phase have been successfully completed for both assigned eastern Mediterranean projects.

For the first project, it was decided in favor of relocating the tie-back host closer to shore after re-evaluation of field development economics, state of current market and regional geo-politics.

As part of the scope re-evaluation, the tie-back host was then progressively moved several times. The host was moved from the original deeper site to one shallower but still utilizing a floating host, to finally being relocated to a much shallower site using a fixed platform.

This final solution was found to be more CAPEX friendly for the execution of the first phase of the project development. However, this option was more onerous in terms of permitting and subject to approvals from additional local agencies and regulatory bodies. The extra approvals from the local entities may indeed present further risk to the project execution if there are delays in getting agreements and approvals as well as potential for increased cost from additional or newly imposed requirements. It is therefore key for NE to have good open communication with and early feedback from all entities reviewing and approving the development. It is also essential for NE to have a strong understanding of all requirements.

As for the second project, further assessment leading to next project phase is pending successful partner agreements, regional negotiations and regulatory approvals.

Through NE's insightful selection and arrangement of IPT team members, the second project was able to take advantage and leverage portion of the work performed for the first field development when its original host was located in the deepwater in similar water depths.

As mentioned, the timely identification and resolution of internal and external interfaces and project risk is key to managing the schedule and budget and ensuring the work is completed on-time and on-budget. Once more, this project proved that effective communication, well defined responsibilities, and presence of knowledgeable team members were essential to the efficient resolution of internal and external interfaces.

For this project I also participated in several risk workshops for the selection of riser solution and floating hull. I also helped coordinate response to riser related internal and external interfaces. I participated and facilitated in the exchanges between affected project teams and third parties such as riser contractor, flexible suppliers, riser top termination supplier, flow assurance, topsides, hull and mooring, controls, systems, operations, materials, quality, health and safety teams.

Prior to moving onto the tendering phase, NE has a great practice of organizing peer review sessions. The peers invited are extremely experienced and knowledgeable individuals generally from NE’s other major projects. They help bring a fresh set of eyes to review the project development choices and decisions. They also help transfer lessons learned from their previous and current projects.

The peers are particularly interested in finding the reasons, justifications and background for some of the choices and decisions taken by the project team. At times, some of the raised questions may be pointed which often places the project manager and, in particular, the project lead on the defensive.

Regardless of the questions and personal feelings, the project team has to address every question raised by a peer. This is certainly a great occasion and opportunity for the project team to objectively reflect and look back on some of their decisions and a time where modifications can still be made without a major change order from contractor(s) or supplier(s).

It is important to note that prior to the tendering phase, most project teams have typically spent so much time down a given solution path, that unfortunately some teams may well have developed a tunnel vision, whereby that the initial decisions that lead to their path may be taken as granted and are no longer questioned or challenged. One major benefit of a peer review is the detection and avoidance of such tunnel visions.

Moreover, peer reviews are a very efficient manner to transfer knowledge and implement the applicable lessons learned from past and ongoing projects across an organization and company. Indeed, the productive discussions and the exchange of ideas during peer review sessions, combined with responses provided by the project team to peers, is a great source for gain and trade of knowledge. The peer review exercise is a great vehicle for circulating and enhancing company's knowledge, best practices and know-hows, and helps groups or project teams break company's work silos and silo mentality.

In summary, this project presented several technical and managerial challenges which were successfully overcome and the various study scopes and engineering work have helped support NE managers in their decision-making and prepared each project for the start of its next phase. I had the great fortune to be surrounded by a large number of remarkably talented and experienced individuals. This experience has helped me acquire new technical knowledge and develop new managerial skills.

## 4.5 NE Assignment – In-House Development of Company Standards and Specifications (FD #5)

### 4.5.1 Scope and Objective

The primary scope of this task was to develop Company standards and specifications to be used and applied uniformly across NE's major projects. The main goal was to enhance operational efficiency, aid with process uniformity across major field developments, and allow better transfer of lessons learned from one project to the next. Ultimately, the objective of this task was to help minimize gaps, discrepancies or inconsistencies in Company standards and specifications that may result in change orders that often add cost to the overall project execution and generate schedule delays due to added scope or rework.

During this market downturn and as part of cost cutting efforts, NE's upper management could appreciate and realize the great added-value from performing this task. They were therefore heavily involved in expediting the completion of this task.

Each document was assigned an owner and a team of experts. Each team of experts was given several fairly strict review cycle deadlines to follow.

### 4.5.2 Accomplished Tasks and Experience

As part of this assignment, I was the riser lead and technical advisor, responsible for the following technical activities:

- Reviewed several riser related specifications, as part of NE's ongoing strategy for enhancing its project execution and operational efficiency, safety and quality.
- Provided comments to document owner related to compliance with current codes, regulations, industry standards, recommended practices and norms.
- Assigned as preparer of riser top termination specifications to be used across Company's existing and future Major Projects. I had previously developed this specification for NE as part of the prototype testing scope (FD #1) which was covered in detail in earlier section.
- Provided language to be used for development of Company's Umbilical Specification with respect to buoyancy modules design, fabrication, installation and operation.

For this rather brief assignment, a summary of non-technical duties I performed is provided below:

- Attended initial kick-off meeting to discuss management's objectives and expected outcome from this brief exercise.

- Participated in several subsequent meetings to discuss progress of each document.
- Provided comments by assigned deadline to each document. It was noteworthy that each document owner had his or her own preferred method for the format and management of comments received.

This effort was a great initiative and vision by NE's upper management towards process uniformity and improved project execution, operational efficiency, safety and quality.

The main technical challenge was that the document owner and all assigned document reviewers had to have excellent familiarity with the current codes, regulations, industry standards, recommended practices and norms. They also had to have a wide view and an intimate knowledge of the content of other Company specification and standards to be able to detect and eliminate gaps, discrepancies or inconsistencies.

From a managerial standpoint the task appeared to be mainly technical, however this was only on the surface and a superficial perception. However, based on my careful observation of the project undertaking and execution, the managerial challenges were found to be quite intricate and not limited solely to the management of a tight schedule and limited budget defined by NE's upper management.

### 4.5.3 Outcome

Although I was involved more from a technical point of view, I still had the opportunity to observe and learn from how this scope was organized, structured and managed.

Indeed there were many positives in terms of how each document was assigned an owner with the responsibility of reviewing previous Company standard(s) and making necessary revisions to incorporate past NE's lessons learned and ensuring compliance with current codes, regulations, industry standards, recommended practices and norms.

It should be noted that most document owners and reviewers were actively supporting other projects and very few if any were dedicated full time to this activity. Yet upper management had set a very tight timeline in an effort to expedite and reduce costs (i.e. time spent on each document by assigned member). To this end, frequent progress meetings were initially held by management, putting peer pressure on owners to deliver documents.

However, ultimately the timeline was found to be over optimistic and had to be revised to accommodate individuals that had a heavy project load as well as being owners and reviewers on multiple documents.

In reviewing several of these specifications it was apparent that better guidelines should be provided to each owner and reviewer to help with uniformity between documents. These should have included common nomenclatures, abbreviations, contractual definitions and language, organization of the table of contents and even more rudimentarily basic guidelines for format and template.

In addition, it would have been beneficial if more time had been spent upfront to define, discuss and clarify the interaction between specifications and need for separation and creation of additional specifications.

After the initial review and consolidation of comments, only the owner was invited to meet with management to present and defend the comments made by one of the reviewers. There was no formal process put in place to discuss comments that management decided not to implement.

Another interesting aspect was that each owner was free to set his/her expectation on a method of receiving comments. Allowing this freedom of choice was very smart on the part of management which had a positive outcome. It was generally interesting to find that some of the owners preferred to use an MS Excel spreadsheet to electronically capture the comments from each reviewer, while some preferred electronical mark-up on the document in MS Word or pdf, yet other owners had designated a review room where the reviewer had the chance to visit and mark their comments directly or with sticky notes on a paper copy of the document (the old fashioned way as those owners called it).

In summary, this exercise was a great initiative, and with further work and definition should bring about the desired process standardization and a great medium for implementation of recent project lessons learned, with positive outcomes in terms of enhanced project execution, operational efficiency, safety and quality.

## 4.6 CVA Assignment – GOM Field Developments

### 4.6.1 Scope and Objective

The primary scope of both CVA assignments was focused on the design, fabrication and installation verification on behalf of BSEE for two different risers associated with two different Oil and Gas developments in the GOM.

Both CVA assignments will be treated under this subsection to avoid repeating similar scope, objectives and description of activities. Distinctions in my involvement and accomplished tasks will be made as applicable.

For both CVA scopes, I have been part of a team responsible for conducting the independent design, fabrication and installation verification.

As mentioned, the installation verification scope for CVA #1 has been suspended, in part, due to the oil market downturn. The operator is seeking to rebid the installation scope of work and a select new installation contractor after the previously selected installation contractor went out of business.

The scope for CVA #2 is currently ongoing and expected to be completed by the end of this year (2016). Cuneiform is working diligently on reviewing and verifying the design and fabrication phase of the project. The verification of the installation phase has not yet started.

### 4.6.2 Accomplished Tasks and Experience

For CVA #1 scope, I provided support and led part of the design verification efforts. I was assigned as the CVA's lead for the installation verification activities. For CVA #2 scope, I am responsible for leading the design verification activities and will most likely provide technical support to the fabrication and installation verification tasks.

The following is a summary of technical activities that I was responsible for:

- Assisted in riser design verification (CVA #1)
- Participated in the preparation and review of the Interim and Final Design CVA reports to BSEE for (CVA #1)
- Responsible for reviewing installation analysis documents as well as coordinating and managing all offshore installation related verification activities and reporting to BSEE. (CVA #1 is pending selection of new installation contractor)
- Attended installation meeting with initial installation contractor (CVA #1)
- Marked documents required for review from the initial installation contractor's master document register (MDR) (CVA #1)
- Reviewed initial installation design basis (CVA #1)
- Responsible for leading the design verification activities and reporting to BSEE (CVA #2)
- Reviewed CVA Plan and Nomination documents (CVA #2)

- Reviewed and discussed Cuneiform's proposed design, fabrication and installation CTRs (Cost, Time and Resource) (CVA #2)
- Reviewed, consolidated and internally discussed comments to partial and full riser design reports issued by riser contractor (CVA #2)

In addition to technical responsibilities described above, the following provides a description of my managerial and my non-technical administrative duties:

- Attended regular meetings and teleconferences to discuss verification progress, outstanding items, upcoming activities and project schedule (CVA #1)
- Participated in the preparation and review of the Interim and Final Design CVA reports to BSEE for (CVA #1)
- Coordinated and lead the initial riser installation verification scope prior to project hold (CVA #1)
- Attended installation meeting with initial installation contractor (CVA #1)
- Coordinating and leading the riser design verification scope (CVA #2)
- Consolidated and discussed comments to riser contractor's partial and full design reports (CVA #2)
- Reviewed and discussed Cuneiform's proposed design, fabrication and installation CTRs (Cost, Time and Resource) (CVA #2)
- Attended KOM meeting with the field operator to meet key members of project team, to ensure project alignment and to discuss design inputs and design basis, review project requirements and project schedule (CVA #2)

- Provided weekly progress update (CVA #1 and 2)
- Managing the CVA design schedule and budget to ensure on-time and on-budget (CVA #2)
- Prepared and submitted timesheets (CVA #1 and #2)

One of the main technical challenge was the development of analytical tools to verify strength and fatigue of the flexible pipe riser. Indeed, as explained in detail in Section 3.3, additional complexities arise with design and analysis of flexible pipes due to the properties, functions and behaviors of each layer and their mutual interactions within the cross-section. Every flexible supplier has developed their own proprietary design tools that contain important empirical parameters and design factors. These tools have been developed, benchmarked and validated based on many years of product R&D, testing and qualification. Therefore, the flexible suppliers are very reluctant to release or share many of these parameters.

For CVA #1 design verification scope, I had helped Cuneiform develop a method and analytical tool to independently verify the flexible fatigue damage within critical layers. This method was then applied for both dry and flood flexible annulus to assess fatigue damage and design life for the given project flexible cross-section.

The primary technical challenge for CVA #2 relates to the in-service interaction between an oil production flexible riser and a small bore steel gas lift riser tubing. The oil production flexible riser is existing and already in-service. The operator intends to insert a small bore steel gas lift riser tubing to help reduce slugging and improve production stability.

The main non-technical challenges for both scopes were related to managing the verification schedule and completing the work within the initially agreed budget. Related challenge was in timely review and verification of implementation to allow close-out of comments.

Effective communication and clarity of expectation between CVA and all interfacing parties are also a fundamental challenge that needs to be managed in order to successfully complete the CVA scope.

### 4.6.3 Outcome

Cuneiform has diligently worked towards completing both scopes to date. The Final Design Verification report has been submitted and approved by the Bureau of Safety and Environmental Enforcement (BSEE) for CVA #1 scope. However, after a brief start of the installation verification scope, the installation contractor went out of business. This scope is now on hold awaiting the operator to rebid the installation scope and select a new installation contractor.

The scope for CVA #2 is currently ongoing and expected to be completed by end of this year (2016). Cuneiform has been working as efficiently as possible in reviewing and verifying the design and fabrication phase of the project.

As mentioned, it is important to highlight that the CVA acts on behalf of the Bureau of Safety and Environmental Enforcement (BSEE), as one of the last line of defense, to ensure that the riser design, fabrication and installation were conducted in full compliance with applicable codes, regulations and standards as to provide the proper level of health, safety and protection for the offshore personnel, the population and the environment.

Cuneiform is amongst the few recognized firms that have been nominated and approved as a Certified Verification Agent (CVA) for design, fabrication and installation verification acting on behalf of BSEE. The engineers working on Cuneiform's CVA assignments have many years of riser experienced and an utmost familiarity with applicable riser design codes, regulations and industry standards and best practices. This helps Cuneiform to execute the verification work in an efficient and effective manner. This is also important to Cuneiform for maintaining its industry reputation and leadership.

In fulfilling this important and crucial verification and certification work on BSEE's behalf, the technical and managerial strength of Cuneiform's CVA team members allows for efficient scope execution and on budget.

Good communication with the operator and its contractor is key to maintaining a tight schedule. During our KOM with the operator, I had the opportunity to meet project team members and discuss project schedule, scope and requirements. Importantly, it was noted that our schedule was very tight and that it was highly dependent on how well the project contractors and suppliers meet the schedule. In addition, we established the project points of contact and agreed to communication protocol.

To help keep our schedule commitment for the design scope, I have been managing and expediting Cuneiform's document review cycle and document turnaround time back to the operator. However, it should be noted that in general the CVA schedule is limited by the speed at which the operator and its contractors can provide acceptable responses to CVA comments. Our comments are closed-out after we have verified that they have be fully addressed and implemented.

Efficiencies are generally enhanced when the operator engages the CVA after the riser design basis and premises have been finalized and when some of the riser design work is underway. For the fabrication and installation CVA it is imperative to award the scope ahead of the start of fabrication and installation scopes to avoid delays or certification issues due to absence of CVA for witness of critical activities. CVA's early involvement also allows them to participate in the review of procedures and specifications and for their comments to be addressed and implemented. CVA also has the opportunity to provide necessary input to the fabrication ITPs and advise which inspection points they desire to witness. To this end, getting CVA engaged early helps establish an efficient communication plan and ensures CVA's presence and witness to verify important activities that they had time to outline and agree with the operator.

Indeed, the coordination and organization of design, fabrication and installation activities require skillful management, effective communication and proper interaction between CVA and all interfacing parties. This is a fundamental challenge to a successful completion of CVA scope.

Thus far, I have had the great opportunity to work with many knowledgeable and experienced individuals on these two CVA scopes. Indeed, this unique experience is helping me develop and acquire new technical and non-technical skills and enhance my overall appreciation of the complexities and subtleties of project management.

# 5. ACHIEVEMENT OF INTERNSHIP OBJECTIVES

The following section describes and demonstrates the completion of all Final Internship Objectives (Tavassoli, 2016). I have elected to group these approved internship objectives based on technical, managerial, societal and personal objective categories to help with the flow of discussion and presentation.

## 5.1 Achievement of Technical Objectives

Several of my final internship objectives were predominately technical in nature. They required and relied on engineering and design expertise, knowledge, experience and good practices. These technical objectives are listed below:

- "Have an outmost familiarity with applicable design codes, regulations and standards.
- Ensure that the design effort conducted is safe and robust in order to provide the proper level of health, safety and protection for the offshore personnel, the population and the environment.
- Ensure that decisions taken help prevent incidents to safeguard the offshore asset and the interest of all stakeholders.
- Active participation in hazard identification and appropriate risk assessment/evaluation." (Tavassoli, 2016)

I believe that I have satisfactorily accomplished all of the above technical objectives as can be demonstrated through the assessment of my performance and the outcome of each of my internship assignments.

Indeed, as described and detailed in previous sections, the technical tasks and activities that I was responsible for carrying out, as part of my internship assignment, necessitated a great familiarity with applicable design codes, regulations and standards. This familiarity and technical expertise were needed for correct hazard identification and appropriate risk evaluation, and required to ensure a safe and robust design, fabrication, installation and operation of riser systems.

As highlighted in the previous sections, I actively participated, as the riser lead and technical advisor, in many hazard identification and risk assessment workshops and studies. In the execution of my assignments, for NE and CVA, my top priority and decision emphasis was on ensuring the health, safety and protection of the personnel, the public and the environment, and to help prevent incidents to safeguard the offshore asset and the interest of all stakeholders.

## 5.2 Achievement of Managerial Objectives

Three of my final internship objectives were prevailingly managerial in nature. These objectives depended on managerial skills such as project management, teamwork, effective communication and interaction, decision making process, project staffing, personnel motivation, accountability and clear definition of roles and responsibilities. The achievement of my objectives also hinged on the understanding of the concepts of business and corporate strategic management, organizational behavior, financial management and engineering ethics. These managerial objectives are listed below:

- "Focus on managerial skills and organizational behavior to enhance team work and dynamic, talent identification and people management.
- Actively observe and familiarize myself with each organization, its personnel, and its management.
- Dynamically interact with my internship supervisor and expert team members to learn best practices and allow knowledge sharing.
- Acquire valuable insight of the organizational vision, mission, values, goals/objectives, competencies, strengths/weaknesses and special processes." (Tavassoli, 2016)

I believe that I have satisfactorily accomplished all of the above managerial objectives as can be demonstrated through my managerial assignments as well as through my internship experience, observations and process examinations.

Both Cuneiform and NE had the great ability to attract and staff their projects with highly knowledgeable and talented individuals. As explained during my management experience on FD # 1 and #2, I was also able to enhance teamwork and team dynamic through good communication, positive motivation, setting common goals and focusing on common purpose.

During my internship and through my various project assignments, I have had the great opportunity and privilege to work directly with Dr. Mekha. I am extremely grateful for his willingness to serve on my doctoral committee and for his great enthusiasm to share his wealth of knowledge and experience. I am also thankful for his guidance and openness throughout our long and fruitful technical and managerial discussions, and exchanges of ideas. Through the various projects that he had assigned to me, I was also able to meet many other knowledgeable and experienced project team members with whom I was able to share knowledge. These experiences and interactions have enabled me to learn, develop and acquire new technical and non-technical skills.

As mentioned in previous sections, NE was able to adopt various knowledge sharing processes across its multiple projects and teams to help improve its organizational and operational efficiencies in addition to other cost cutting measures to weather through the ongoing market downturn.

Furthermore, during my internship I have been able to observe and familiarize myself with each organization and meet some remarkable individuals. This deep immersion and organizational involvement has undeniably enabled me to acquire valuable insight to the organizational vision, mission, values, goals, objectives, competencies, strengths, weaknesses, threats, opportunities and special processes.

My DE courses and internship experience have definitively provide me with special perspective on management and have helped me examine and elucidate past and new management views, opinions and ideas. Hence, the DE program has been instrumental in supporting the continual development and growth of my managerial skills.

## 5.3 Achievement of Societal and Personal Objectives

I have elected to categorize two of my internship objectives as both societal and personal. These objectives are listed below:

- “Be open to new ideas and processes.
- Gain required knowledge and experience to be able to take the PE exam to become a registered Professional Engineer.” (Tavassoli, 2016)

On the surface one might think that these objectives are solely personal and reflective of my individual desire to be open to new ideas and processes and prepare and pass my PE exam.

My reasoning for classifying these objectives as both societal and personal is founded on my belief that our engineering decisions and choices are closely entwined with our impact on others and vis-a-vis the society. Indeed, engineers have the ability to benefit and affect society in a very unique way.

I believe that through this internship I have demonstrated that I am open to new ideas and processes both on technical and non-technical levels. I also believe that I have gained additional knowledge and experience toward my goal of becoming a registered Professional Engineer (PE).

## 5.4 Contributions to Peers, Society and Industry during my Internship

During my internship, I accepted the invitation to peer review several technical papers for the ASME 2016 – 35th International Conference on Ocean, Offshore and Arctic Engineering (OMAE) that was held in Busan, South Korea. OMAE's main aspiration is to create an international forum composed of engineers, managers, researcher and students to share and exchange technological and scientific ideas, findings and experiences in order to encourage progress in the ocean, offshore and arctic engineering fields (OMAE, 2016).

I also became a member of API's Houston Chapter during my internship with the goal of being an active contributor to the advancement of our engineering field, industry and society through participation in API organized meetings and activities.

Once more, I had the great opportunity of being invited to present at one of TAMU's Ocean Engineering seminar sessions on the topic of the "First FPSO project development in the US Gulf of Mexico". It is always a great privilege to be able to share my experience and knowledge with my fellow Aggies and learn through our mutual discussions.

# 6. OBSERVATIONS AND LESSONS LEARNED

In this section I would like to summarize some of my observations and lessons learned based on my internship experience that I believe may help companies and organizations to weather and survive a market downturn.

Indeed, my internship was marked by the oil and gas market downturn in part due to local and global economies, geopolitical tensions, market share battles and mêlées among major oil producing countries such as those part of OPEC, and independent energy companies, leading to excess production rates and surplus that has deflated the oil price since its high back in 2013.

The following operational efficiencies and suggested transformations are believed to be beneficial considerations and practices during a market downturn and should be suitable even in strong market conditions:

- Operational efficiency in combination with cost control – it is to be noted that I differentiate operational efficiency and cost control combination from the "simple" exercise of cost cutting across the entire organization. Indeed, the combination will result in "smart" cost cuttings or savings in most areas of operation, while in some other areas such as R&D and innovation, where it is suggested to possibly maintain same level of funding and activity as in a strong market, the combination of operational efficiency and cost control regime ensures that the allocated funding is spent in an accountable, efficient and more productive manner.

- Innovation and R&D – these are areas that most companies tend to eliminate first during a market downturn, but I believe it may be a big mistake. Indeed, when companies stop R&D efforts and the search for innovative products, services and solutions, they are operating in what I would like to call a default mode which is reliant on marketing their existing products. The downfall of this approach is that, eventually their competitors or an agile newcomer may be able to catch up and produce better products. Thus, the companies that elect to operate in default mode often find difficulty surviving the market even after it has grown strong again. As with any innovative solution it is important for companies to consider the upfront cost of qualification versus the risk of failure which may result in loss of reputation and loss of market share. Moreover, the cost of a failure may potentially be several orders of magnitude more than the upfront qualification cost. Hence, when it comes to R&D and innovation, it is important to balance short-term cost cutting objectives with long-term success and productivity.
- Company collaboration – in any market, certain company collaborations through strategic alliance and partnership could yield huge cost savings via knowledge, budget and risk sharing.
- Mergers & acquisitions (M&A) – M&A undertaken with the right company and for the right reasons can help with a company's competitiveness and increase its earnings. During a downturn, it may be an ideal time to take advantage of great M&A deals. However, companies need to exercise caution

when considering M&A as most end up unsuccessful due, in part, to misjudgments, lack of upfront due diligence, or improper execution of the M&A amongst several potential failure reasons.

- Enhancing communication and breaking silo mentality – establishing effective communication and knowledge sharing is found to be key to project operational efficiencies. The importance of sharing experience, knowledge and lessons learned from past projects and proper implementation in current and future projects is a great approach for enhancing company's operational efficiency, and breaking the silo mentality and counterproductive internal competitions. As part of this process, peer reviews can be an effective instrument for questioning the status quo and for effective experience and knowledge sharing.
- Industry cooperation and information sharing – other than issues with internal communication within an organization and with its stakeholders, it is also important to note that information sharing with others in the industry tends to reduce in a downturn market. For instance, companies tend to send fewer individuals to participate in conferences, industry meetings, workshops, training and learning sessions as part of cost cutting measures. They also tend to avoid publicizing equipment problems or failures in part to keep a competitive edge.
- Talent identification, retention and acquisition – this is another important area where many companies fail both when the market is up or down. The lack of

talent identification can be particularly harmful to the company if the "wrong" person is kept and the "wrong" person is cut. Indeed, the cost of losing a high potential employee and hiring a replacement may be several times that individual's salary. Furthermore, it is important for organizations to create a sense of trust and loyalty when it comes time to survive a down market. Many organizations resort to job cuts and elimination of office amenities as the first and sometimes the only real cost reduction measure. Often times, the operating processes and procedures are untouched and continue to be inefficient and rigid. Continuous and constant job cuts luring on employees backs from week to week is very stressful and distracting to say the least. It also reduces the sense of trust and loyalty if not done right. On the positive side of this equation, smart organizations realize that in a market downturn there is a larger pool of talented and high potential individuals to select from and hire. It is important to note that such action and recognition can create a mutual trust and loyalty with these talented and high potential individuals. Moreover, when the market gains strength it will become more difficult to hire the right talent.

- Proper staffing of projects and organizations – This encompasses not only knowing the strengths of each individual and creating a strong team that works well together, but also providing the right staffing level by eliminating redundant functions and roles, and looking for complementary strengths. It is as important to avoid understaffing as it is overstaffing. Understaffing would create personnel overload, excessive stress, potential gaps in knowledge and expertise, and may lead to inefficiencies, missed opportunities, misjudgment, errors and loss of motivation. The proper staffing of an organization is also crucial and it is essential to identify personnel strength, to define clear functions, roles and responsibilities, and to avoid redundant layers of management.

- Recognizing the loss of experienced personnel due to age gap – this is particularly true in the oil & gas industry. The age/experience gap has been exacerbated by the market downturn whereby very experienced personnel in senior positions have been provided early retirement package incentives or simply let go. It is important for organizations to create effective processes to help with the transfer of this wealth of knowledge and experience.
- Ability to adapt and change – indeed companies that are able to adapt and change have the advantage of being more agile and innovative. These advantages are both in terms of the ability to develop and adopt more efficient operational methods and processes, as well as in adjusting to changes in market demands.
- Proper evaluation of risk – indeed without the awareness of hazards and/or the misjudgment of the likelihood of their occurrence, individuals and companies are prone to making poor and costly decisions in terms of health, safety and the environment affecting their personnel, public and stakeholders. It is often during a market downturn that organizations can get themselves in great trouble by taking on more risks, with all emphasis placed on cost reduction,

and at times lose their focus off safety and product quality. To make matters worse, companies may decide to use less experienced personnel, suppliers and contractors solely to cut costs. It is essential to ensure that quality and inspection requirements are not sacrificed and removed as part of cost cutting efforts. Sacrificing quality and inspections increases the risk of inadequate components which may lead to costly rework or failures with potentially catastrophic consequences.

- Positive cash flow and access to capital – in today's market we see many companies struggling to pay their debts and maintaining a positive cash flow. Indeed a company without a positive cash flow and without access to additional capital may have to start selling its assets or part of the company, otherwise it may quickly find itself in default. It is vital for companies to monitor their cash flow as part of their cost control process.
- Importance of leadership – company leadership is important at all times, however great leadership is critical during market downturn. It is, indeed, the type of management leadership, during a market downturn, that determines how well a company will weather the downturn and if it emerges stronger as the market improves.

## 7. SUMMARY AND CONCLUSIONS

My internship experience in combination with the course work I have completed as part of my Doctor of Engineering degree plan, has been instrumental in helping me learn and put into practice new technical and managerial skills, and grow my overall understanding of the many intricacies of project management.

In the process of accomplishing my assignments and internship objectives, I have had the tremendous opportunity to meet and work with many knowledgeable and experienced individuals who have contributed to my professional development and influenced my approach to management and problem solving.

The internship assignments were unique and challenging from a technical and a managerial point of views. The challenges and demands for the execution of my project assignments provided me with a greater appreciation of the importance of teamwork, communication, management, leadership and organizational structures and cultures.

Indeed, the overall outcome of any project can be judged and lessons learned by assessing its technical rigor and robustness as well as the efficacy in its managerial decisions, approaches, processes, priorities and execution.

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# APPENDIX A

## INTERNSHIP SUPERVISOR'S FINAL REPORT

**Final Internship Report for Mr. Armin Tavassoli**

**September 30, 2016**

## Introduction

This document represents the Final Internship Report in relation to the fulfillment of the Mr. Armin Tavassoli's Doctor of Engineering (D. Eng.) degree requirements at Texas A&M University. This final report summarizes the scope of Mr. Tavassoli assignments under my supervision, his effort and responsibilities and my assessment of his performance.

Mr. Tavassoli was assigned to support two completely different types of projects and for two different clients. One of the clients was Noble Energy, an Independent Energy Company, operating projects in deep water environment in the US Gulf of Mexico and in other parts of the world. The other assignment was to be part of Cuneiform Offshore team acting as Certified Verification Agent (CVA) for two projects in the Gulf of Mexico on behalf of the Bureau of Safety and Environmental Enforcement (BSEE).

The main objectives and goals of Mr. Tavassoli are related to developing the technical and managerial skills to support even larger project and advance his experience to higher levels. Some of these objectives can be briefly summarized:

- Establish familiarity with the applicable design codes, regulations and standards.
- Ensure that the design effort conducted is safe and robust in order to provide the proper level of health, safety and protection for the offshore personnel, the population and the environment.
- Interact with the project team members to learn best practices, allow knowledge sharing and ensure proper decision making process.
- Focus on managerial skills and organizational behavior to enhance team work, talent identification and people management as well as observe the structure of each organization, its personnel, and its management.

**Assignment #1 (Noble Energy Projects)**

Mr. Tavassoli's Noble Energy assignment was to provide technical and management support to multiple Noble Energy offshore projects in deep water. These projects are located in the Gulf of Mexico and in the Eastern Mediterranean region. Mr. Tavassoli was part of Noble Energy Integrated Project Team for the projects he was supporting. One particular focus of Mr. Tavassoli's involvement was the design, fabrication and installations of the risers and their components such as flexible joints which provide the means for connecting the risers to the floating production facility.

*Noble Gulf of Mexico Projects*

Mr. Tavassoli was responsible for overseeing the design and supporting the procurements and manufacturing of the riser components such as pipe, strakes, coating etc. He also managed the procurement and delivery of the riser flexible joints as the riser top termination units. Furthermore he supported Noble installation team by providing technical support to ensure safe installation of the risers. The risers of the Gulf of Mexico projects have been successfully completed and installed. Furthermore, Mr. Tavassoli also provided the technical support for the manufacturing of spare flexible joint for one of Gulf of Mexico projects.

*Noble Eastern Mediterranean Project*

Mr. Tavassoli's main scope for the Eastern Mediterranean project was to provide technical support for the challenging design of the risers connected to a floating production and storage system. This was the initial concept of the project which had also led to having Noble Energy perform full fatigue test qualifications for two flexible joints as proof of concept in anticipation of the project adopting the concept. Mr. Tavassoli was closely involved with the riser designer to ensure reaching a feasible design that satisfies the design codes and standards as well as supports the necessary procurement, fabrication and installation feasibility requirements. The design of the risers was successfully completed and the flexible joint fatigue test qualifications had already started when the project concept was changed and dynamic risers were no longer required.

Noble Energy had decided to continue with the flexible joint fatigue test qualification programs for the two flexible joints and assigned Mr. Tavassoli to be the responsible engineer to complete the program. The test program of the first flexible joint was successfully completed around April-May 2016 and the other was completed in June-July 2016. The two final reports issued and extensively reviewed and discussed with the flexible vendor and re-issued as final before the end of July 2016. Mr. Tavassoli was instrumental in managing the design of the flexible joints from the beginning and through the procurements and testing phases of the project. His technical knowledge and management experience in dealing with the vendor and his communication skills with Noble Energy have shown significant improvement during the course of the work. Mr. Tavassoli has kept me abreast of the progress and we had had many technical exchanges and strategy discussions which I believe have enhanced his appreciation to the work.

**Assignment #2 (CVA Projects)**

Mr. Tavassoli's second assignment was to be part and lead some aspects of the design, fabrication and installation activities associated with the verifications of risers for two Gulf of Mexico projects for the same operator.

The first project is to perform the CVA activities for the design, fabrication and installation of a new riser to be connected to existing floating production system. Mr. Tavassoli was involved in the design verification scope by performing some aspects of the design activities. Mr. Tavassoli performed the independent fatigue analysis of the riser as well as reviewed some of the design documents and made comments. He also participated in writing section of the Final design CVA report and reviewing the entire report before submitting it. The Final Design Verification report has been submitted and approved by Bureau of Safety and Environmental Enforcement (BSEE) with copy sent to the Operator for their information. Mr. Tavassoli was assigned to lead the verification of the installation activities but after a brief start including the review of the design basis document, the selected Installation Contractor went out of business. Therefore, this scope is now on hold awaiting a new bidding process and new award to a different installation contractor.

The second project is currently underway and covers the CVA activities associated with modifications to an existing riser connected to a floating production facility. Mr. Tavassoli is currently leading the design CVA effort. He will most likely be also involved in and support some of the fabrication and installation CVA activities associated with the project. This CVA scope is expected to be completed by the end of this year, 2016.

In my capacity as the Project Manager for both of these CVA projects, I have had the opportunity to work closely with Mr. Tavassoli and oversee his work. He has done an excellent job. I have been impressed with his thoroughness and dedication to the work. The CVA scope requires complete knowledge of the issues involved and understanding of the approach taken by the operator and its contractors to ensure safe and reliable design, fabrication installation and operation of the risers.

**Summary and Conclusions**

I have been supervising Mr. Tavassoli's along the way in the aforementioned projects and scopes observing his progress in all relevant aspects as someone pursuing his degree and as he is representing my company, Cuneiform Offshore Consulting. Mr. Tavassoli skills, knowledge and technical and managerial capabilities are excellent and have significantly improved during the implementation of these completely different projects and different responsibilities. I strongly believe that Mr. Tavassoli has made significant progress and has met the goals and the objectives that he and the University have set for him to obtain his Doctor of Engineering degree.

**CUNEIFORM OFFSHORE CONSULTING, LLC**
**Floating Systems, Risers, Pipelines**

*Basim Mekha, Ph.D., P.E,*

*President, Cuneiform Offshore Consulting, LLC*

# APPENDIX B

## VITA

## VITA

Name: Armin Tavassoli

Permanent Address: 26 Gleannloch Estates Dr., Spring, TX 77379

Email Address: armin.tavassoli@yahoo.com

Education:

- Doctor of Engineering, Texas A&M University, College Station, USA, 2016
- M.S., Ocean Engineering, Texas A&M University, College Station, USA, 1999
- Dipl.-Ing., Civil Engineering, Ecole Spéciale des Travaux Publics, Paris, France, 1998
- Deug A Diploma, Mathematics & Physics, Paris VII University, Paris, France, 1995

Professional Summary:

- Over 15 years of experience in marine research and offshore industry, primarily in the field of floating systems, deepwater risers and pipeline systems.
- He has held various roles as client and contractor, including Lead Engineer, Project Manager, and Technical Advisor providing consultancy services for riser, pipeline, umbilical, and mooring system projects.
- Past experience includes developing a numerical code capable of simulating nonlinear wave-current-structure interactions that account for the effect of fluid viscosity.